A SYSTEM DYNAMICS INVESTIGATION OF ENVIRONMENTAL ATTITUDES AND BEHAVIORS INFLUENCING SOLID WASTE REDUCTION

THESIS

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Captain Louis E. Lilley

Presented to the Faculty of the Graduate School of Engineering

of the Air Force Institute of Technology

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Engineering and Environmental Management

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Abstract

The relationship between attitudes and behavior is investigated in regard to the reduction of solid waste in a community. The theory of reasoned action, as identified by Ajzen and Fishbein in 1975, is investigated using as system dynamics approach. The closed loop system structure that would produce the expected real-world response is established. The structure is then translated into a flow diagram and coded into a mathematical model. The model quantifies the values of beliefs, attitudes, intentions, behaviors, external and demographic variables, perceptions, and waste generation levels in order to illustrate how each changes over time when influenced by other variables. The model is tested to verify a model response in agreement with the expected outcome. Finally, suggestions of possible uses of the model are illustrated and discussed. Possible uses include investigating the relative weights of the demographic and external variables, investigating responses to different policies, testing other attitude-behavior theories, and guiding future research in attitude-behavior theory.

Chapter 1
Introduction

Introduction

The volume of solid waste being generated is currently seen as a problem. This perception affects peoples beliefs about waste generation, and according to Fishbein and Ajzen (1975), this change in beliefs affects peoples attitudes, behavioral intentions and behaviors. However, the behavior dictates the amount of waste generated. We have therefore identified a dynamic causal loop structured around the generation of solid waste with influences from attitudes and behaviors. Such a system can be useful in determining the causes of high waste volumes, but more importantly, once the system is identified and understood, it may be helpful in determining how to reduce the volume of waste being generated.

Background

Levenson stresses that many areas of the country are seeing shortages of permitted landfill capacity due to older landfills reaching their maximum capacity, closure of substandard landfills, and the difficulty in opening new landfills (Levenson, 1993, pg. 22.) It is this decreased capacity of existing landfills that is generating concern about the solid waste problems, and causing much of the current solid waste legislation to be introduced (Alig, 1993, pg. 97.) The Roper Organization found that the main causes of solid waste problems are similar nationally and locally, as perceived by Americans (The Roper Organization, 1990, pg. 9.) Further, any local crisis becomes a national concern, because as local landfills reach their capacity, the entire nation confronts the crisis (The Roper Organization, 1990, pg. 10.) This is evident when looking at such problems as New York City disposing of its trash at Fresh Kills, the city's only landfill, which is scheduled to close by December 31, 2001. Once the landfill is closed, New York City will be

forced to export its waste. In 1987, Long Island tried unsuccessfully to unload a barge full of trash for two months. After traveling 6000 miles and stopping in several cities in various countries, the barge ended up returning back to Islip, NY, and the garbage was burned in a Brooklyn incinerator.

Gigliotti suggests that the roots of environmental problems may result from the basic foundational values of society, such as individualism, materialism, limited government, progress, and growth (Gigliotti, 1992, pg. 15.) In their report on the trends in municipal solid waste in America, Franklin Associates, Ltd. discuss a growing predisposition of people to waste things because of a decline of a conservation ethic. They state there is evidence that shows a changing set of values in our society which may lead to waste (Franklin Associates, Ltd., 1992, pg. ES-5.) During the depression and wars of the early half of this century, more effort was placed on conservation. The second half of the century, on the other hand, can be seen as a lessening of that conservationism as more people travel, commute, eat out, change residences, delay marriage, buy disposable products and prepared foods, employ more mothers, drive more cars and engage in more recreational activities.

Porter, Leeming, and Dwyer claim that to alleviate the solid waste problem, we can reduce the amount of waste initially generated or increase recycling after waste is disposed of (Porter, Leeming, and Dwyer, 1995, pg. 123.) However, Konheim and Koehler claim that recycling will not solve the waste problem alone. People are opposed to other alternatives, such as landfilling and incineration. If we are to manage the waste successfully, the solution needs to include the alteration of human behavior, since the crisis is a result of behaviors that are not favorable to reducing solid waste (Borden and Schettino, 1979, pg. 35, Tracy and Oskamp, 1983-84, pg. 115.)

Hamid and Cheng agree with Borden and Schettino that environmental problems result from "maladaptive behaviors" (Hamid and Cheng, 1995, pg. 680.) However, managers often try to encourage the frequency of behaviors favorable to solid waste reduction without first encouraging the behavior itself (Hamid and Cheng, 1995, pg. 683.) Once the behavior has been initiated, the prior experience of the behavior will further encourage the behavior. It is then important to increase the frequency of the new, favorable behavior. Oskamp and others stress the need for psychological research in this area (Oskamp et al., 1991, pg. 495.)

The federal government and many state environmental agencies have begun to require policies dealing with behavioral, in addition to technical, solutions to reduce waste. Waste minimization and recycling are included in behavioral solutions (Vining and Ebreo, 1992, pg. 1581.) Research in the psychological aspects of waste reduction can help increase understanding of the factors that influence participation in waste reduction programs (Vining and Ebreo, 1992, pg. 1581.) Such an understanding of the factors will help managers find solutions to the waste problem that would be acceptable to the community, rather than solutions that would upset the community, such as policies requiring certain behaviors restrictive to established lifestyles. (Karp, 1997, pg. 131.) People will be happier if they feel like they freely chose the behavior rather than having been told to act in a certain way. An understanding of the factors will also help ensure the success of public policies aimed at reducing waste by influencing a conglomeration of individual actions (Arbuthnot, 1977, pg. 217.)

Oskamp comments that research efforts should increasingly utilize long-term longitudinal approaches when dealing with environmental issues (Oskamp, 1983, pg. 255.) Such long-term efforts should focus basic values on conservation rather than consumption. Such a reorientation will require an extensive change of values in a community (Oskamp, 1983, pg. 265.) However, in

the long run, such approaches may be less costly than high-technology solutions (Oskamp, 1983, pg. 268.)

The relationship between attitudes and behavior are of concern when dealing with waste reduction because managers want to know what drives actions and how these actions can be changed. Alwin states that there are two dominant forms of this interest. The first deals with predicting the behavior from verbal attitudes, while the other deals with predicting behavioral responses through the nature of the observed relationships between verbal attitudes and behavior (Alwin, 1973, pg. 253.) Prediction is good, but this thesis deals with the theoretical concern, which desires to identify the causal relationships among the relevant variables so that an understanding of the observed relationships can be obtained (Alwin, 1973, pg. 254.) Alwin suggests that such an approach can best be accomplished by viewing the system in terms of a set of causal assumptions relating the variables.

Individual and group attitudes toward the environment and beliefs about the salient environmental issues have been very important for the field of environmental studies (Bruvold, 1973, pg. 202.) Noe and Snow describe values and attitudes as providing "a cognitive map defining specific courses of collective action" (Noe and Snow, 1990, pg. 27.) Several attempts at creating such a map have been made, including the theory of reasoned action, in an effort to increase understanding of behavior systems (Goldenhar and Connell, 1992-93, pg. 91.) The theory of reasoned action is simply the Extended Fishbein Model, which is essentially a modification of Dulany's theory of propositional control. Its primary use is in explaining, predicting, and modifying specific behaviors (Lutz, 1977, pg. 97.)

The concept of the dynamic process when dealing with integrated solid waste management has been discussed (Franklin Associates, Ltd., 1994, pg. 2-3.) Lutz explains that previous

behavior studies using the Extended Fishbein Model focused on static, correlational systems that allowed no investigation of causal relationships among the variables. However, the Extended Fishbein Model was designed for a dynamic system, and its full use as a predictive model will remain underutilized until it can be demonstrated that changes in certain variables result in changes in other variables. Once this has been accomplished, the model can be used to determine the best way managers can attempt to change undesirable behaviors (Lutz, 1977, pg. 197.) Lowenthal agrees that a sustained systematic analysis needs to be performed (Lowenthal, 1972, pg. 333.) Also, the connections, strengths, and weaknesses of each of the variables of the system needs to be explored (Lowenthal, 1972, pg. 334,) as well as the interactions of environmental perception, intention, and expectation in regard to environmental behavior (Lowenthal, 1972, pg. 334.) Finally, we need a better understanding of the external variables on the system, such as cultural and natural influences, to better understand the environmental beliefs, attitudes, and behaviors (Lowenthal, 1972, pg. 335.)

McKechnie believes that people should all gather the same information about the environment but, due to our varying beliefs and attitudes, interpret it differently (McKechnie, 1977, pg. 274.) This thesis will look into the demographic characteristics of communities, but it will represent a cross section of a general community. This will eliminate any variation in personal differences in interpretation of information that would be found on a smaller scale. It is the premise of this model that differences in the external predictors will result in differences in perceptions of the problem of solid waste or in the solutions that must take place in order to resolve the problem.

Problem Statement

Given the fact that current rates of solid waste generation are seen as a problem, the following problem statements addresses this concern as well as the need to reverse the trend of increasing waste generation rates.

1. It is currently difficult for a community to maintain optimum integrated municipal solid waste management (IMSWM) procedures.

2. It is also difficult to anticipate desires of the community when behaviors dynamically interact with the goals.

3. An understanding of the dynamic influence structure of the attitude-behavior system is required to better control the components of the system, allowing for modifications to community behavior in favor of reduced solid waste disposal rates.

Research Questions

If we view the theory of reasoned action as a dynamic structure with causal influences, then it would not be inappropriate to use a system dynamics approach to explore the actual generation of waste from a behavioral standpoint. The following questions address the attitude behavior system in a system dynamics manner:

1. What are the components of the system that will accurately portray the expected system response?

2. What are the external influences that best determine the magnitude of the response of the system?

3. Once a better understanding of the system is gained, how can the external influences be adjusted to achieve desired waste level reductions?

Chapter 2
Literature Review

Introduction

To change solid waste disposal volumes, we need to change behavior. According to the theory of reasoned action, we need to change beliefs, which will in turn change attitudes, intentions, and behaviors. This chapter will discuss some of the background of system dynamics, the theory of reasoned action, demographic variables, and external variables as they pertain to behaviors and the resultant change in the volume of solid waste generated.

Cyclical Trends of Waste Disposal

In 1972, Downs described how over the years, interest waxes and wanes as people's perceptions of problems change. Newer, hotter topics replace older problems that are seemingly impossible to solve. Given enough time, the problem will resurface as the 'new' problem to solve. Since solid waste can be generalized along with other environmental topics, then we can view the current trend in solid waste as cyclical.

Downs describes a systematic issue-attention cycle that seems to strongly influence public attitudes and behaviors regarding many domestic problems. According to Downs, this cycle is rooted in the nature of certain problems as well as in the way the media portrays the problem to the people. There are three characteristics that define which social problems will enter this cycle (Downs, 1972, pg. 41.) First, the majority of persons in society are not suffering from the problem nearly as much as some minority. Second, the suffering caused by the problem is generated by social arrangements that provide significant benefit to a majority or a powerful minority of the population. Finally, the problem has no intrinsically exciting properties. Solid waste can be viewed as one of these problems. Most Americans view industry as the biggest

generator of solid waste, but only a few Americans are actually suffering from the waste. These people are usually in urban areas surrounded by vast quantities of waste, or they are in certain small communities that are receiving the waste. Either way, they feel they have no control over either the amount of waste generated or the placement of the waste after disposal. We can certainly say that waste is not intrinsically exciting.

The cycle itself has five stages (Downs, 1972, pg. 39, Dunlap, 1991, pg. 286-87.) The first involves a pre-problem stage, when the problem exists but has not yet become a focus of public attention. The next stage is the alarmed discovery, when a dramatic event or series of events brings the problem to the forefront. Stage three is the realization of the cost of significant progress. At this stage the public becomes aware of the costs needed to correct the problem, both economically and in terms of lifestyle changes. The fourth stage is the gradual decline of the intense public interest, where the problem still exists but the public has other problems to focus on. Finally, the fifth stage is the post-problem stage, where the problem exists in 'limbo.' The problem has not disappeared, but is no longer a subject of public interest. We have not returned to stage one because of some of the residual effects of the previous stages. For instance, when solid waste is at stage three, several programs, such as curbside recycling, may be created that will linger into stage five and continue even though the problem of solid waste has lost attention. Lifestyle changes do not change quite as quickly as public interest.

Dunlap and Scarce explain this cycle in terms of a "low salience" (Dunlap and Scarce, 1991, pg. 652.) Problems like the environment tend to have a low salience, which causes peoples' interests in the problem to grow and decrease over time. The problem never really stays in the limelight. They note that although the environmental problems have increased in salience and relative importance, the strength of the concern is hard to determine (Dunlap and Scarce, 1991,

pg. 654.) They note that there has definitely been an upward trend in environmental concern during the 1980s, especially with local problems such as solid waste (Dunlap and Scarce, 1991, pg. 654.)

The Roper Organization states that major attitudinal changes generally precede behavior changes, whether in individuals or in society at large. Therefore, the attitudinal shifts of society in the 1980s should lead to changes in behavior in the 1990s. Ungar also suggests that the focus of environmental concern changes over time (Ungar, 1994, pg. 293.) Schwartz and Miller contend that attitudinal changes generally precede behavioral ones, and agree with the Roper Organization that the important attitudinal shifts of the 1980s will gradually change environmental behavior in the 1990s (Schwartz and Miller, 1991, pg. 35.) The changes may not be dramatic however. They may be slow, may not encompass every group, and may even be derailed, if only temporarily (The Roper Organization, 1990, pg. 81.) However, Franklin Associates, Ltd., have already found that trends in source reduction have led to steady changes in the composition and quantity of MSW (Franklin Associates, Ltd., 1994, pg. 1-5.)

It can be said that we are currently somewhere on the cycle. We are aware that waste is a problem and we are trying to generate less of it. By stage five, the generation level should be at a steady-state value. The need to reduce waste will be balanced with the cost to reduce waste. Any programs in effect will remain in effect, although stronger efforts will be disregarded, primarily due to cost, both economically and in terms of lifestyle changes. Dunlap discusses trends in public concern for environmental quality, starting with their beginning in the mid 1960s and continuing through to the twentieth anniversary of Earth Day in 1990 (Dunlap, 1991, pg. 286.) He states that the issues have not reached the last stage of Downs's issue attention cycle, the post-problem stage (Dunlap, 1991, pg. 302.) Because environmental problems hold conditions that Downs

identified as being able to prevent their disappearance from public attention, such as increasing in threat, threatening the public at large, and having ambiguous effects, the natural decline into stage five has not occurred as expected (Dunlap, 1991, pg. 308.)

In reference to changing the cycle, Borden believes that global long-term change will require an environmental ethic stemming from a deeply internalized and highly integrated attitudinal and value system (Gray, 1985, pg. 188.) Further, any specific attitudinal change strategies will probably have little or no effect because treatments tend to be of short duration. Without the reinforcement, the behavior returns to its initial state (Gray, 1985, pg. 187.) Krause claims variation in perception due to the notion of a "cycle" in public attitudes about environmentalism may be important (Krause, 1993, pg. 129.)

Theory of Reasoned Action

In 1975, Martin Fishbein and Icez Ajzen released a book detailing the theory of reasoned action (TRA). The TRA began as an extension of Dulany's "theory of propositional control" to social behavior (Ajzen and Fishbein, 1970, pg. 466.) During the 1960s and 1970s, several attitude-behavior models were developed, but by far the most prominent and influential of these models has been the Fishbein/Ajzen model, which specifies a 'recursive chain causal structure' (Liska, 1984, pg. 62). However, some researchers are not convinced that the causal structure underlying the relationships between cognitions, attitudes, intentions and behavior is in fact recursive (Liska, 1984, pg. 67.) Figure 2-1 illustrates the theory of reasoned action in the form of a structural diagram, with arrows indicating influences.

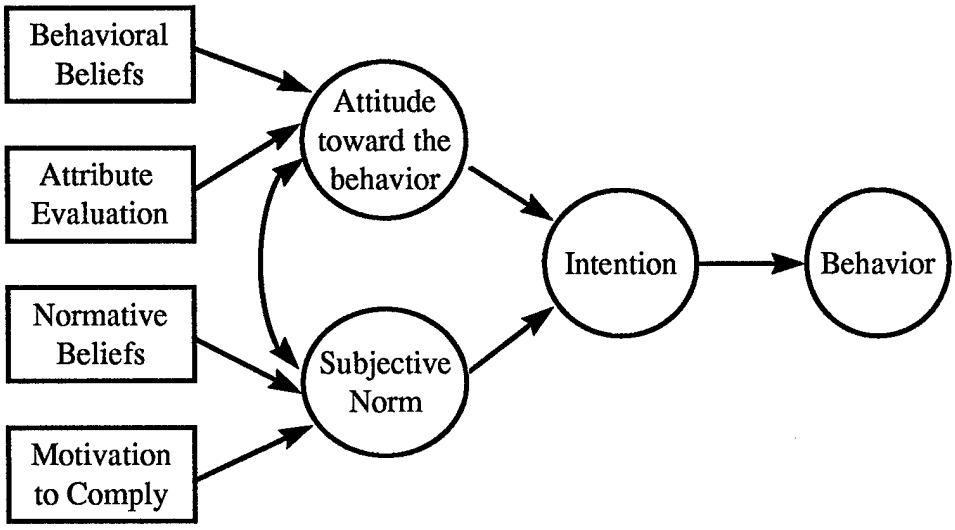


Figure 2-1 Theory of Reasoned Action (adapted from Ajzen, 1991, pg. 182.)

Hamid and Cheng feel that the TRA is one of the most influential contributions to the literature on the causal link between attitudes and behavior. The TRA is a straightforward conceptual and empirical model for measuring the relationship between beliefs, attitudes, intentions and behavior (Hamid and Cheng, 1995, pg. 680.) It has proved useful in predicting reported behavior from beliefs and attitudes in a wide variety of settings (Hamid and Cheng, 1995, pg. 681.) Goldenhar and Connell have found that the hypothesized direction of influence among the major components of the TRA is "generally supported" (Goldenhar and Connell, 1992-93, pg. 92.) Thøgersen claims it is the most popular model in attitude research on recycling behavior (Thøgersen, 1996, pg. 539.) It forms the backbone of the causal model in this thesis, with a final influence placed between the completion of behaviors and the formulation of beliefs.

The TRA defines the relations between external variables and the behaviors that are under an individual's volitional control (Ajzen and Fishbein, 1980, pg. 9.) Ajzen and Fishbein state that the TRA is based on the assumption that people are rational and make systematic use of the information available to them. Unconscious motives or overpowering desires do not control behavior. People consider the implications of their actions before they decide whether or not to

engage in a given behavior (Ajzen and Fishbein, 1980, pg. 5.) In the TRA, behavior is determined by behavioral intention, intention is determined by attitude and social norms, attitudes are determined by beliefs about consequences and evaluations of the beliefs, and social norms are determined by beliefs about the norms of significant others and motivation to comply (Thøgersen, 1996, pg. 539.)

Behavior is an overt, observable act that can be studied in its own right (Fishbein and Ajzen, 1975, pg. 13.) Behavioral intentions are a special type of belief, where the object is always the self and the attribute is always a behavior (Fishbein and Ajzen, 1975, pg. 12.) Belief is defined as the "information a person has about an object," and it links an object to an attribute (Fishbein and Ajzen, 1975, pg. 12.) Fishbein and Ajzen define attitude to be "a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object" (Fishbein and Ajzen, 195, pg. 6.) They also say that residues of past experience influence or modify behavior. Since attitudes are generally assumed to constitute residues, they are considered learned (Fishbein and Ajzen, 195, pg. 9.) In other words, the previous behavior forms the learning opportunity that alters the attitude, which then drives the next behavior, hence the cyclical loop.

Laudenslager discusses conservation behavior and points to an observation by Lee, DeYoung and Morans, who found that prior behavior has a strong affect on subsequent behavior, but again the level of specificity is important (Laudenslager, 1996, pg. 2-27.) In fact, Laudenslager states that Hamid and Cheng feel that past behavior is the best predictor of what people intend to do (Laudenslager, 1996, pg. 2-27, Hamid and Cheng, 1995, pg. 683.) However, economic motivation can work against promoting consistent behavior because it undermines intrinsic satisfaction that can motivate people (Laudenslager, 1996, pg. 2-28.) When evaluating

the past behavior to determine the appropriate future behavior, the consequences of the behavior, including time and money costs, must be weighed against the benefits. To show the importance of convenience in a conservation program, Morans, Lee, Guagnano, and DeYoung found that careful design and management of the method of waste reduction can result in a high level of participation (Laudenslager, 1996, pg. 2-18.)

Again, Fishbein and Ajzen conclude the attitudes are learned because they are residues of past experience (Fishbein and Ajzen, 195, pg. 6.) Petty and Cacioppo discuss propaganda and education as another way to teach people information, with propaganda being nonfactual or making an opinion seem as fact, and education being factual and teaching how to think logically so people can make up their own minds (Petty and Cacioppo, 1981, pg. 3.) Persuasion can be either propaganda or education. Learning produces a relatively stable change in behavior that results from prior experiences (Petty and Cacioppo, 1981, pg. 40.)

However, whether a favorable or unfavorable attitude exists, there is still no expectation that a given behavior will result (Fishbein and Ajzen, 1975, pg. 9.) This tells us that there are other influences affecting behavior. Just as the TRA can be seen as a causal structure, the influences on the generation of solid waste can be seen as causal. Solid waste generation is directly influenced by the recycling rate. The recycling rate is influenced by, among other things, the intention to recycle. The other things vary depending on the situation. For instance, physical barriers in one community may be different from another. Specific barriers such as no curbside recycling, no market for certain materials, conflicting regulations already in place, and lack of funds to staff the program, differ between communities.

Ungar points to other variables that may influence behaviors more than attitudes, such as knowledge, motivation, social norms, and attitude toward the act, and contends that these

variables have a greater influence than attitudes toward the object (Ungar, 1994, pg. 295.) According to Guagnano, Stern, and Deitz, external conditions impose boundaries on attitude theories. As the external variables increase and dictate the behavior response, these theories lose their predictive value. When the external conditions are less extreme, attitudes have a more dominant predictive role in explaining behavior (Guagnano, Stern, and Deitz, 1995, pg. 704.) In addition, Goldenhar and Connell contend that modifying the TRA to include additional variables will improve the model's predictive abilities (Goldenhar and Connell, 1992-93, pg. 92.)

Theory of Planned Behavior: The theory of planned behavior (TPB) is an extension of the theory of reasoned action which overcomes the TRA's limitation in dealing with behaviors over which people have incomplete volitional control (Ajzen, 1991, pg. 181.) In the TPB, perceived behavioral control is added. Perceived behavioral control refers to a person's perception of his or her ability to perform a particular behavior (Vennix, Akkermans, and Rouwette, 1996, pg. 54.) When people have complete control over behavioral performance, intentions alone should be able to predict behavior, barring external influences as specified in the TRA (Ajzen, 1991, pg. 185.) The TPB implies that intentions and perceptions of behavioral control will each influence the prediction of behavior (Ajzen, 1991, pg. 188.) This would add a third set of beliefs to behavioral and normative beliefs, which would be the control beliefs (Ajzen , 1991, pg. 189.) Ajzen contends that persuasive communications directed at normative or control beliefs, such as propaganda or education, will influence subjective norms and perceived behavioral control as outlined in the TRA (Ajzen, 1991, pg. 198.) Figure 2-2 illustrates the theory of planned behavior in the form of a structural diagram, with arrows indicating influences.

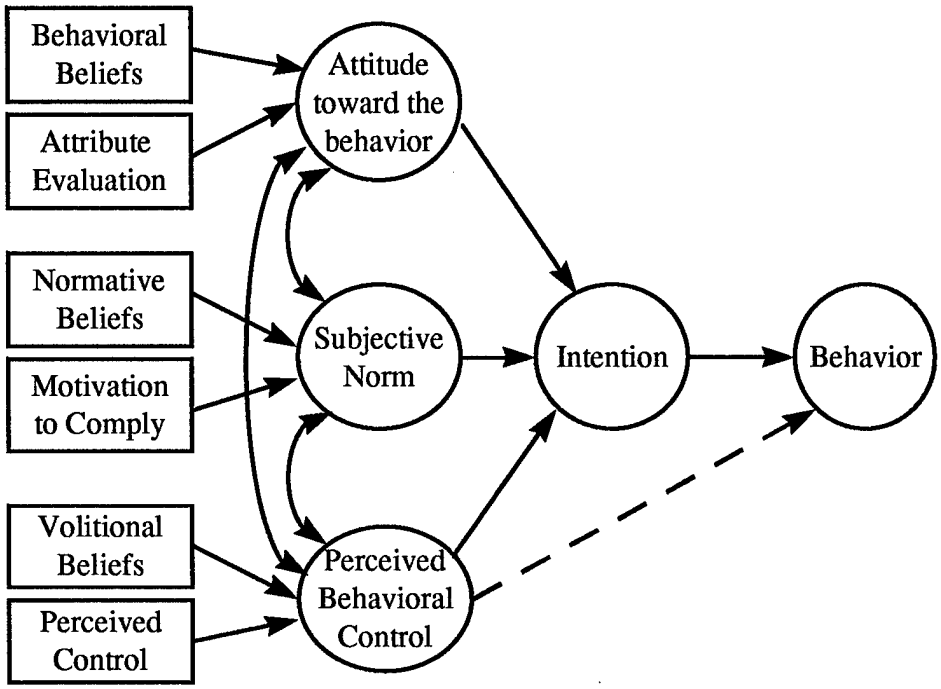


Figure 2-2 Theory of Planned Behavior (from Ajzen, 1991, pg. 182.)

Although the TPB is accepted, it is newer and does not have the wide literature background that the TRA has. However, as seen later in Chapter Four, this thesis incorporates barriers to behavior into the TRA that the society cannot control, at least in the short term. These barriers can be assumed to represent the lack of perceived volitional control over the behaviors, or the lack of control can be assumed to be included in the barriers to behavior, in which case the shortcoming of the TRA as identified by Ajzen is addressed.

Behavior

According to Fishbein and Ajzen, behaviors are "overt, observable acts" of a subject under study (Fishbein and Ajzen, 1975, pg. 13.) By grouping many behaviors, observed on different occasions and in different situations, the result will represent a more valid measure of the underlying attitudes than observing just one behavior. The multiple sources of influence in the group of behaviors tend to cancel each other out (Ajzen, 1991, pg. 180.) However, broad

attitudes may only have an impact on specific behaviors, by influencing some other factors that are more closely linked to the behavior in question (Ajzen, 1991, pg. 181.) If all the factors influencing behavior are known, then behavior can be predicted to the limit of the measurement error (Ajzen, 1991, pg. 202.)

Arbuthnot summarizes his review by stating that there is increasing evidence that personality and attitudinal traits play a moderating role between a person's perceptions of environmental issues and their behavioral responses (Arbuthnot, 1977, pg. 219.) Behavior strongly favored by the attitudes of most people will result in action that is most common, whereas behavior strongly opposed by attitudes will be rare (Guagnano, Stern, and Deitz, 1995, pg. 702.) Attitudes toward an object will be more favorable as the number of past behaviors that are favorable increases (Bruvold, 1973, pg. 206.) Again, attitude is identified as being influenced by behavior, indicating the circularity of the TRA.

Luthans and Krietner are more pessimistic about the causality of behavior. The learning approach, based on the works of B. F. Skinner, defines operant behavior as a function of its consequences. They state that the concepts of operant behavior describe how the environment actually controls learned behavior rather than causes it (Luthans and Krietner, 1975, pg. 13.) Behavior is strengthened, maintained, and weakened by its consequences. The situation only presents the occasion for the person to respond which is, in turn, followed by a consequence, but the situation does not cause the response (Luthans and Krietner, 1975, pg. 41-42.)

Dunlap and Scarce found that the public supports the environmental movement and exhibits high levels of behavior in regards to protecting the environment (Dunlap and Scarce, 1991, pg. 656.) More and more people report having made some changes in personal behaviors, including various forms of recycling (Dunlap and Scarce, 1991, pg. 657.) Changes in behavior

can affect the environment in two ways. First, people can either buy or reject environmentally unsound products. After the purchase, they can either recycle the products or send them to the local landfill (Schwartz and Miller, 1991, pg. 28.) However, the most popular behaviors are usually those that require minimal effort and cost to the individual (Dunlap and Scarce, 1991, pg. 657.) Behaviors that are difficult, expensive, or inconvenient will result in the action being rare, whereas those associated with strong positive conditions will be more common (Guagnano, Stern, and Deitz, 1995, pg. 702.)

Tracy and Oskamp state that the assumption appears to be that diverse behaviors toward the environment, such as recycling, originate from some common underlying characteristic like conservationism, and that each behavior is interchangeable as an index to the characteristic (Tracy and Oskamp, 1983-84, pg. 116.) However, some authors conclude that there appears to be no generalized factor of ecologically responsible behavior. The same construct may not be measured when different behavioral criteria of conservation are used (Tracy and Oskamp, 1983-84, pg. 117.)

There are various ways to manipulate behavior directly, such as physical barriers prohibiting any behavior despite intent, incentives that encourage a given behavior despite the beliefs, and legislation that forces compliance despite attitudes. These will be discussed later in this chapter.

Intentions

Behavioral intentions are described as the best possible predictor of a person's behavior (Bentler and Speckart, 1979, pg. 453, Petty and Cacioppo, 1981, pg. 199.) Intentions mediate the effects of the attitude toward the act and of normative beliefs on overt behavior. Attitude toward the act itself has been found to be more influential than the attitude toward the object in

question (Ajzen and Fishbein, 1970, pg. 483.) Therefore, the prediction of intentions is a necessary and sufficient condition for the prediction of behavior (Ajzen and Fishbein, 1970, pg. 469.) Because intentions mediate behavior, prediction of intentions is the immediate concern of the TRA (Ajzen and Fishbein, 1970, pg. 467.) Intention to perform a behavior is important because it captures the motivation to act, which indicates how hard people are willing to try, or how much effort they are planning to exert to perform a behavior. The stronger the intention to perform a certain behavior, the more likely the behavior will be performed (Vennix, Akkermans, and Rouwette, 1996, pg. 51.)

In regards to intention, it is assumed that one should do what one wants, barring physical impediments. (Fishbein and Ajzen, 1975, pg. 298.) The lack of this volitional control is the basis for modifying the TRA into the TPB. Specific behavioral intentions are assumed to be formed or held which influence the subsequent overt actions. (Fishbein and Ajzen, 1975, pg. 301.) According to Ajzen and Fishbein, an appropriate measure of intention is needed to provide the best prediction of behavior (Ajzen and Fishbein, 1980, pg. 41.)

Intentions are used to predict behavior, but each can vary along a level of specificity, which is defined through the target object, situation, and time. The levels increase from a very global level to a very specific level, which accounts for the behavior, situation, and time as seen in Figure 2-3.

Level	Specificity
I	Global
II	Cluster
III	Specific Behavior
IV	Behavior and Time or Situation Specific
V	Behavior, Time and Situation Specific

Figure 2-3 Level of Specificity, (taken from Fishbein and Ajzen, 1975, 296.)

Levels III through V, which are the most specific of the five levels, are of main interest, but these are the levels that are the hardest to predict (Fishbein and Ajzen, 1975, pg. 292-298.) Behavior, on the other hand, is always specific, and has four elements; behavior, target, situation, and time (Fishbein and Ajzen, 1975, pg. 352.) Behavioral intentions are determined by two major factors; the personal, or attitudinal, factors, and the social, or normative, factors. Although both deal with attitudes, keeping them separate gives a better understanding of the way in which behavioral intentions are formed (Fishbein and Ajzen, 1975, pg. 304.) The personal factors result from the attitude toward performing the act, and the social factors result from beliefs about what is expected in a given situation, or the normative beliefs (Ajzen and Fishbein, 1970, pg. 467.) Attitude is defined as the sum of the behavioral beliefs multiplied by the evaluation of the attribute. Subjective norm is defined as the sum of the normative beliefs multiplied by the motivation to comply. The attitude and subjective norm are then multiplied by their respective weights (which sum to one) and are added together to determine the behavioral intentions (Ajzen and Fishbein, 1970, pg. 467.) In Thøgersen's review, he found the social norm to be either not significant or substantially less influential than the attitude in determining intention (Thøgersen, 1996, pg. 540.) The attitude and subjective norm are discussed in more detail below.

Behavioral intentions are unstable and frequently only formed just before behaving, which makes them an uninteresting and ineffectual predictor of behavior (Liska, 1984, pg. 67.) Ajzen and Fishbein found that individual intentions are less stable over time than aggregate intentions because events are less likely to balance out. They state that prediction of behavior from intention at the aggregate level is often remarkably accurate, even when individual predictions are not, except when external influences change the intentions (Ajzen and Fishbein, 1980, pg. 48.) It is important to remember that the measure of intention will accurately predict the behavior only if

the intention does not change before the behavior is observed, which is why the time of the measure is important (Ajzen and Fishbein, 1980, pg. 52.)

Lutz found that intention is approximately equivalent to overt behavior. To obtain the best possible prediction of behavior, the intention measure should be situation specific and should be taken as close as possible prior to the behavior. Also, there must be a high degree of volitional control over the behavior (Lutz, 1977, pg. 198.) Without the volitional control, the model would need a third component as described in the TPB. Lutz claims that his results strongly support the power of the attitude toward the act to predict the intentions. In the presence of attitudinal control, changes in attitude will be reflected in intentions (Lutz, 1977, pg. 206.)

The usual assumption with behavior theory is that if the attitudes can be changed, then the behaviors can be influenced, resulting in a social change. Attempts to bring about changes invariably leads to exposure to new information about the target. (Fishbein and Ajzen, 1975, pg. 387.) Note that the salient beliefs must change for the attitudes, and subsequently the behaviors, to change. A change to any single belief or to several beliefs may not produce a change to the sum of beliefs. A change of beliefs comes from active participation, or prior behavior (Fishbein and Ajzen, 1975, pg. 388), which provides the opportunity to acquire new information (Fishbein and Ajzen, 1975, pg. 412.) Attention and comprehension will determine the content of what is learned, but this does not ensure the knowledge will be accepted or adopted (Fishbein and Ajzen, 1975, pg. 452.) Again, for intentions to change, the attitude and subjective norm must be attacked at the same level of specificity (Fishbein and Ajzen, 1975, pg. 400.) A change in intention may not affect the behavior if the levels of specificity are not exact. Also, an influence attempt may produce unexpected intentional changes that prohibit the desired behavioral change (Fishbein and Ajzen, 1975, pg. 405.)

The TRA identifies three variables that are the basic determinants of behavior: attitudes towards the performance of the behavior, normative beliefs, and the weights of these predictors. Any other variable that is to influence behavioral intentions will do so only indirectly by influencing one or more of these determinants. Behavioral change is expected to be produced by changing the behavioral intentions, which are changed by our ability to affect its predictors and their weights (Ajzen and Fishbein, 1970, pg. 483.)

Some authors have suggested that there are other determinants of behavior besides behavioral intentions, such as habits or feasibility (Ajzen and Fishbein, 1970, pg. 486.) Ajzen and Fishbein also indicate that an intention has not yet been performed, and it may not always be possible to carry through an intention because of various kinds external factors (Ajzen and Fishbein, 1970, pg. 486.)

Hamid and Cheng, found that it is not clear how well multiple act behavioral intentions predict specific behaviors, but behavior specific intentions appear to predict specific acts quite well (Hamid and Cheng, 1995, pg. 683.) They cite Madden, Ellen, and Ajzen as stating that when there is complete control over the behavior, intentions are sufficient to predict the behavior (Hamid and Cheng, 1995, pg. 685.) They also state that intentions likely depend on the occurrence of past behavior (Hamid and Cheng, 1995, pg. 694.) Past behavior affects intentions, but intentions are influenced by attitudes, which are influenced by beliefs. The beliefs are influenced by past behavior.

Attitudes

This section consists of a general discussion on attitudes, followed by discussions on attitudes toward the behavior, the subjective norm, the motivation to comply, and the weights associated with the attitudes and subjective norms.

Petty and Cacioppo describe attitudes as "convenient summaries of our beliefs" (Petty and Cacioppo, 1981, pg. 8.) They state that the assumed relationship between attitudes and behaviors has been studied carefully and we can now conclude confidently that attitudes are related to behaviors (Petty and Cacioppo, 1981, pg. 24.) They remind us that the time elapsed between two measures will affect the correlation between attitude and behavior (Petty and Cacioppo, 1981, pg. 27.) They also state that we can predict better if we consider other external variables (Petty and Cacioppo, 1981, pg. 28.)

Attitudes and subjective norms are important because of their influence on intentions, rather than their direct impact on behavior (Bentler and Speckart, 1979, pg. 453.) Myers and Halstead state that when external factors shape attitudes, the attitudes will translate into a particular behavior (Myers and Halstead, 1992, pg. 412.)

Fishbein and Ajzen claim that external pressures cause people to behave inconsistently with their attitudes, even though the attitudes influence behaviors (Fishbein and Ajzen, 1975, pg. 343.) They discuss an other variables approach, but find the approach to be based on poor assumptions, therefore making it not useful or consistent with their theory (Fishbein and Ajzen, 1975, pg. 351.) The approach states that some variables influence attitude, while some influence behavior directly. Examples of variables include other attitudes; individual differences; competing motives; verbal, intellectual, and social abilities; presence of other people, either actual or considered; consequences of various acts, either actual or expected; and unforeseen extraneous acts (Fishbein and Ajzen, 1975, pg. 344, Wicker, 1971, pg. 18-19.)

Wicker, however, states that the attitude-behavior inconsistency is supported by using multiple predictors to predict behaviors (Wicker, 1971, pg. 29.) Wicker refers to DeFleur and Westie's suggestion that attitudes should be thought of as specific rather than as general response

tendencies. This way they may be viewed as probabilities of specific forms of response to specific social objects (Wicker, 1971, pg. 27.) Wicker concludes his discussion by noting a shift toward greater specificity of the response measures (Wicker, 1971, pg. 28.) In order to do this, three alternatives are suggested. First, redirect the attitude measure from the object of the behavior to the behavior itself. Second, use global measures of attitude to employ other, more specific, verbal measures. Finally, study the overt behavior of interest and the variables which affect that behavior directly, rather than through the attitude and other verbal predictors (Wicker, 1971, pg. 28, 29.)

Liska does not believe the causality represented in the TRA is sufficient. Liska states that the specific beliefs which underlie subjective norms are not necessarily different from those which underlie attitudes (Liska, 1984, pg. 68.) Also, the TRA does not account for the causal relationship between attitudes and social norms. It treats the two variables independently. Liska feels that this may oversimplify the causal structure, resulting in an inaccurate representation that inhibits further research (Liska, 1984, pg. 69.)

According to Ungar, individual attitudes are collected into public opinion, which ideally influences public policy toward the environment (Ungar, 1994, pg. 289.) Bruvold concludes by finding attitude related to two variables, information and experience (Bruvold, 1973, pg. 215.) However, Schwartz and Miller claim that almost every American is pro-environment in their attitudes, but their strong attitudes are modified when looking at consumer behavior (Schwartz and Miller, 1991, pg. 28.) According to Thøgersen, though, attitudes are a function of the person's moral beliefs (Thøgersen, 1996, pg. 537.) These beliefs are modified before being translated into behavior.

Borden and Schettino note other authors who suggest that approaches should focus on either affective or cognitive experiences to bring about behavioral changes (Borden and Schettino,

1979, pg. 38.). Some suggest a program which emphasizes affective experiences to cause cognitive and behavioral changes, while others suggest teaching facts and concepts about the environment. They cite Southern as saying "if the child acquires particular broad environmental understanding (knowledge) he will develop social conscience (attitude) that will affect his behavior (actions) toward the total environment" (Borden and Schettino, 1979, pg. 39.) They conclude by stating that both affective and cognitive experiences are needed to develop the most environmentally responsible action (Borden and Schettino, 1979, pg. 39.)

Behavioral Attitudes: According to Ajzen and Fishbein, Thurstone identified attitudes toward an object as being related to a pattern of behavior with respect to the object, but without a necessary relation between attitude and any given behavior (Ajzen and Fishbein, 1980, pg. 15.) The same attitude can be expressed in different actions, giving ideas of an overall pattern of behaviors (Ajzen and Fishbein, 1980, pg. 18.) Weigel states that attitudes represent consistent sets of beliefs and feelings about an object which predispose the people holding the attitude to act in a particular way toward that object (De Young, 1988-89, pg. 342.)

However, there is debate about the usefulness of the attitude toward an object. The attitude is not necessarily related to intention to perform a given behavior with respect to that object, but should influence the general level of favorability expressed by the intentions (Fishbein and Ajzen, 1975, pg. 291.) Likewise, it is assumed that behavior with respect to an object is in large part determined by attitude, but attitude should be related to the collection of behaviors rather than any given behavior (Fishbein and Ajzen, 1975, pg. 335.)

The attitude toward the behavior may be a more useful measure of behavior (Ajzen and Fishbein, 1970, pg. 483.) It is the degree to which a person makes a favorable or unfavorable decision about the behavior in question. Beliefs link a behavior to a certain outcome, which forms

the basis of the decision. The more favorable the outcome appears, the higher the intention to behave favorably. (Vennix, Akkermans, and Rouwette, 1996, pg. 52.) Thøgerson reiterates the need to measure the attitudes toward carrying out the behavior in question rather than the attitude toward the program, or the object. Although attitudes toward the object may predict behavior, the attitude toward actually performing the behavior is a better predictor (Thøgerson, 1994, pg. 151.)

When discussing their research in particular, Vennix, Akkermans, and Rouwette make the assumption that there is an outcome which is valued by the participants, and the outcome is positively linked to cooperation (Vennix, Akkermans, and Rouwette, 1996, pg. 52.) Thøgersen found that the structure of influences on attitude can be classified in many ways. For instance, Pieters distinguishes between perceived costs and benefits (Thøgersen, 1996, pg. 540.) As a result, many studies found that the attitude toward recycling depends on the favorability of the public benefits that result from recycling (Thøgersen, 1996, pg. 541.)

Vining and Ebreo cite Van Liere and Dunlap as stating that each person selects a different means for showing concern for the environment. Therefore, researchers should not focus on general attitudes, but rather on specific attitudes towards different conservation behaviors (Vining and Ebreo, 1992, pg. 1581.) However, several authors have suggested that general conservation attitudes influence specific attitudes towards conservation issues (Vining and Ebreo, 1992, pg. 1581.) One measure of general environmental concern is the New Environmental Paradigm (NEP), which measures a "constellation of attitudes" that represent adherence to a worldview of the relationship between society and the environment (Vining and Ebreo, 1992, pg. 1582.) The NEP will be discussed in more detail in the beliefs section.

Bruvold claims that belief structures supporting a positive attitude toward home separation and sorting are established, but the problem may deal with negative experiences associated with the inconvenience of separation and sorting (Bruvold, 1973, pg. 215.) It is an important characteristic of source separation that most benefits are shared with the society while the behavioral costs are placed on the individual or family" (Thøgerson, 1994, pg. 150.) In terms of the behavioral costs, Thøgerson found that "added trouble" was one of the three most frequent reasons given for not wanting to recycle (Thøgerson, 1994, pg. 153.) Again the cost is to the individual while the benefits are shared by society.

Subjective Norm: The second determinant of the intention to behave is the subjective norm. The subjective norm consists of the likelihood that important referents approve or disapprove of performing a behavior, combined with the person's motivation to comply with these referents. Stated differently, a person is more likely demonstrate the behavior in question if either important referents approve of the behavior or if the person is inclined to value the referents' opinions (Vennix, Akkermans, and Rouwette, 1996, pg. 53.)

According to Newhouse, social norms can modify the relationship between attitudes and behaviors. In the absence of social norms, the association between attitudes and behavior can be strong, but social norms can prevent people from acting upon their attitudes (Vining and Ebreo, 1992, pg. 1583.)

Oskamp and others state that one significant predictor of curbside recycling participation was recycling by one's friends and neighbors, which demonstrates the importance of the social norm in predicting behaviors (Oskamp et al., 1991, pg. 515.) Recycling can be influenced by social and societal factors as well as by personal motives, attitudes, and beliefs (Vining and Ebreo, 1992, pg. 1584.)

However, Lutz points out the need for more investigation of the normative component in the TRA. Research is needed to understand how social factors influence the system to determine under what conditions normatively based change strategies can influence intentions and behavior (Lutz, 1977, pg. 206.)

Motivation to Comply: The motivation to comply is the least understood of the normative component. It can be thought of as general tendency to accept the directives of a given reference group or individual. It is influenced by the referent's power over the subject, the referent's power to reward or punish the subject, the subject's liking of the referent, the referent's perceived expertise, and the extent of the referent's legitimacy to make demands of the subject (Fishbein and Ajzen, 1975, pg. 306.) Personality characteristics also affect the motivation to comply, such as need for approval or affiliation, self esteem, and authoritarianism. Although the measurement of this variable has been unsatisfactory, research has found variance in its measure to be very small, giving results obtained with the normative component alone to be as good as those with the motivation to comply multiplied in (Ajzen and Fishbein, 1970, pg. 468.)

Weights: In regard to the individual weights that can influence intention, Ajzen and Fishbein found no good procedures to determine the values of the individual weights. However, the relative importance of each component can be estimated for a group of individuals with respect to a single behavior or for a given person with respect to a set of behaviors. The estimates can then be used in the prediction of intention (Ajzen and Fishbein, 1980, pg. 59.) Borden claims that if either the attitude toward the behavior or the subjective norm receives a significantly larger weight than the other, then there will be an indication of how to influence the system, either through individuals or through groups (Gray, 1985, pg. 157-58.)

Lutz states that the weights can be estimated empirically through multiple regression procedures. Again, the magnitude of the weights can determine if a particular action is under attitudinal or normative control. Knowing this information can provide direction for the manager in determining which strategies will be most successful (Lutz, 1977, pg. 198.)

Beliefs

This section consists of a general discussion on beliefs, followed by discussions on behavioral beliefs, social beliefs, and the New Environmental Paradigm.

The determinants of belief are the experiences that lead to beliefs, either directly through observation, indirectly by accepting information from outside sources, or indirectly through inferences. Beliefs are dynamic and can persist, be forgotten, or be created (Fishbein and Ajzen, 1975, pg. 217, Ajzen and Fishbein, 1980, pg. 63.) A person's beliefs represent the information one has about the world (Ajzen and Fishbein, 1980, pg. 79.) In terms of source separation and recycling, Thøgerson found attitudes toward source separation are formed by evaluating the salient beliefs concerning outcomes of behavior. This salience of beliefs results because at any given time only five to nine beliefs about an object are used to determine the attitude toward the object (Fishbein and Ajzen, 1975, pg. 218.) For a community, a representative sample will reveal the modal salient beliefs of that community. The modal salient beliefs consist of the ten to twelve most frequently mentioned beliefs, or those beliefs that exceed a certain frequency (Ajzen and Fishbein, 1980, pg. 70.) This limited hierarchy of beliefs prevents the magnitude of the attitude from increasing indefinitely as new beliefs are gained (Bentler and Speckart, 1979, pg. 453.)

Doran also discusses salient beliefs, stating that collections of beliefs, both cognitive and affective, may produce attitudes which represent a behavioral predisposition toward a given object. Then groups of attitudes will collectively form values which produce behavior. Finally,

beliefs, attitudes, and values will change when they are no longer satisfying to the individual (Doran, 1977, pg. 54.)

According to Shalom Swartz's norm activation theory, in which people act or behave in accordance with a developed personal norm so that they may avoid feelings of guilt or other negative self-evaluations, norms must be "activated" or they will remain simply thoughts and attitudes and will not lead to behavioral changes (Myers and Halstead, 1992, pg. 412.) Individuals must be aware of the consequences of their actions for the rest of society and must show some sense of responsibility to engage in such action or behavior (Myers and Halstead, 1992, pg. 412.)

Krause cites Feldman as stating that attitudes about environmentalism depend on the nature of the core beliefs that are held (Krause, 1993, pg. 128.) However, Schwartz and Miller found that most people, as consumers, are not willing to act on their beliefs (Schwartz and Miller, 1991, pg. 26.) Therefore, there must be some other influence acting on the behaviors, which will be discussed further in the section on external influences.

Behavioral Beliefs: The behavioral beliefs are the beliefs that the behavior leads to certain outcomes. They are modified by the evaluations of these outcomes (Ajzen and Fishbein, 1980, pg. 8.) Behavior is better explained once its determinants have been traced to the underlying beliefs. Beliefs reflect a person's past experience, and demographic variables can be very global indices of different prior experiences (Ajzen and Fishbein, 1980, pg. 90.) External variables have no consistent effect on the beliefs underlying behaviors. Therefore, they must influence behavior directly. To understand behavior, its determinants must be traced back to the underlying beliefs. To change behavior, enough of the beliefs must be changed (Ajzen and Fishbein, 1980, pg. 91.)

Attitude theory suggests that while global attitudes are poor predictors of specific behaviors, values are important because of their measurable impact on behavior, despite their generality (Karp, 1996, pg. 115.) Ajzen states that although there is plenty of evidence for significant relations between beliefs and their corresponding attitudes, the exact form of these relations is still uncertain (Ajzen, 1991, pg. 206.)

Social Beliefs: Normative beliefs are the beliefs that a person holds about whether or not specific individuals or groups think the behavior should be performed. They are modified by the motivation to comply with the specific referents (Ajzen and Fishbein, 1980, pg. 8.) For the normative beliefs, only the salient referents will influence the person's subjective norm (Ajzen and Fishbein, 1980, pg. 74.) In their theory, Ajzen and Fishbein still have not clarified the nature of the normative component (Ajzen and Fishbein, 1970, pg. 467.) The referents will change with the situation, and the referent can be a general or a specific other person or persons (Ajzen and Fishbein, 1970, pg. 486.) Personal normative beliefs, where the subject is also the referent, may need to be considered (Ajzen and Fishbein, 1970, pg. 467.) According to Karp, Schwartz describes an altruism model. Altruistic behavior occurs when individuals hold personal norms with regard to a specific behavior. These norms result from being aware of the consequences of the behavior and the acceptance of personal responsibility for the behavior (Karp, 1996, pg. 113.)

De Young discusses intrinsic motivation in terms of people finding "their own reasons to recyling, to begin to even like doing so, and, as a result, to continue to perform these behaviors on their own" (De Young, 1985-86, pg. 282.) People may enjoy ordinary behaviors, and often do many things without the promise of reward. Conservation incentives include the satisfaction of living a frugal life style, a sense that personal actions matter, a feeling of coherence between personal efforts and society, and an overall sense of well-being (De Young, 1985-86, pg. 282.)

De Young feels that people are not simply waiting for the next extrinsic reward to motivate them into action. People can obtain personal satisfaction from doing activities that managers often try to externally mandate. He suggests that managers should use resources to enhance personal satisfactions which can result from conservation activities. Also, it may be important to find out why environmentally appropriate behaviors would be found satisfying and intrinsically motivated and focus on these results (De Young, 1985-86, pg. 289.) De Young asserts that conservative behavior is part of our survival instinct, which explains the intrinsic motivation, and that there should be no need for external reinforcement (De Young, 1985-86, pg. 290.) However, intrinsic values need to be distinguished from social influence by separating the influence of informal and formal sanctions from intrinsic motivation, and by measuring the effects of external factors on the formation of values (Karp, 1996, pg. 131.)

New Environmental Paradigm: The subjective norm discussed by Fishbein and Ajzen (1975, pg. 301,) can be viewed on a larger scale as the "New Environmental Paradigm" (NEP), as detailed by Dunlap and VanLiere (1978, pg. 10.) A paradigm can be defined as a group's way of looking at the world, or its entire "constellation of beliefs" (Gooch, 1995, pg. 514.) According to Abbott and Harris, a dominant paradigm is defined as "the collection of norms, beliefs, values, habits, and so on that form the world view most commonly held within a culture." This personal conception of social reality guides a community's expectations (Abbott and Harris, 1985-86, pg. 220.)

The NEP is a new world view that suggests the 'Dominant Social Paradigm' (DSP) no longer holds true. The DSP held that people are superior to nature, that abundance and progress are good, and that science, technology, and a laissez-faire economy will conquer all environmental problems, while a limited government and private property rights are favored (Dunlap and

VanLiere, 1978, pg 10.) The NEP on the other hand favors a steady-state economy, limits to growth, preserving the balance of nature, and accepting nature on equal terms with man, who is a part of nature (Dunlap and VanLiere, 1978, pg 10.) If, as believed by Fishbein and Ajzen, general attitudes can predict specific behaviors, then maybe the NEP, as a general list of attitudes, can be used to predict the behaviors of people in terms of a specific behavior such as solid waste reduction or recycling. If the subjective norm is one predictor of behavior, and the NEP reflects the subjective norm, then data on the NEP might be used to aid in predicting behaviors.

However, Dunlap and VanLiere found that attitudes and behavior may not be linked so easily, especially when using general attitudes such as those found in the NEP (Dunlap and VanLiere, 1978, pg. 17.) Since the public may hold inconsistent attitudes with regard to the NEP without realizing the conflict between the NEP and the DSP, they may also engage in behaviors which are inconsistent with the NEP (Dunlap and VanLiere, 1978, pg. 17.)

Stern and others studied whether the NEP can be considered a "generalized belief" that underlies more specific beliefs and attitudes regarding the environment (Stern et al., 1995, pg. 724.) They constructed a causal model similar to the TRA, but include an influence from general beliefs, consistent with the NEP, on beliefs and attitudes (Stern et al., 1995, pg. 726.) People's values and worldview act as filters to eliminate new information that is not consistent with current values and views. Any information that is consistent will be allowed to influence beliefs and attitudes. Their conclusions were that generalized ecological beliefs, such as the NEP, may indeed be linked in the attitude-behavior system (Stern et al., 1995, pg. 738), but they feel that actual causal links must further be strengthened through empirical work (Stern et al., 1995, pg. 728.)

Vining and Ebreo found the NEP to be reliable and valid based on empirical work using the scale in different research samples. It is also widely applicable to different conservation

contexts (Vining and Ebreo, 1992, pg. 1582.) However, Gooch cites Stern as claiming that the NEP is a "cause" of environmental concern, although Gooch contends that the NEP may be the result rather than the cause of ecological awareness (Gooch, 1995, pg. 536.)

Attitude-Behavior Relationships

In viewing the TRA we must look further at the cyclical nature of the theory, including its causality, the feedback structure, and any cited discrepancies in the theory. The feedback structure includes the concepts of perception and past behavior, as will be discussed further.

Causality: In order for a system dynamics approach to be relevant, we must establish the causality of the cycle. A causal flow is postulated in the TRA. The assumption of causal relationships among the constructs in the model underlie the hierarchy of effects (Lutz, 1977, pg. 198.) Causal relations are traditionally established between variables by experimentation, in which one or more variables are systematically manipulated. The effects upon a response variable are measured (Lutz, 1977, pg. 198.) Although experimentation produces correlational data, which does not imply causation, recent developments in path analysis, an analysis of correlational data, make it possible to derive causal inferences from non-experimental data (Lutz, 1977, pg. 199.) Samdahl and Robertson also found that it is possible to determine direct causal effects from indirect effects using causal modeling techniques (Samdahl and Robertson, 1989, pg. 77.)

Causality itself produces an open system. In order to have a dynamic system, the system structure must be closed. To do this, feedback must connect behaviors to beliefs. Doran describes the feedback cycle very well. In his words:

> One's experiences are first perceived by the individual through sensory channels. These perceptions are then assimilated into existing cognitive and evaluative structures if the new experiences are consistent with the individual's existing structures. If the new experiences are not consistent with the existing patterns of

interpretations, these will change if enough significant and valid perceptions are received.

> The belief an individual holds about a given object, concept, or idea (cognition) and the effective interpretation of it (evaluation) together form one's attitude about the experience. Both one's belief and one's evaluation must be positive for one to have a positive attitude. Clusters of attitudes form values which in turn influence one's behavior patterns, as do the skills which are developed along the way. Taken together, the values one possesses and the behaviors one exhibits have been known as one's life style. These, in turn, influence one's perceptions, beliefs, and evaluations. As with most learning situations, this model involves a cyclical process with a feedback loop. (Doran, 1977, pg. 55.)

Perception: Perception is the process by which behaviors are converted back to beliefs. Lober and Green discuss the importance of perception of need as an influence on attitudes (Lober and Green, 1994, pg. 33,46.) The perception arises from the imbalance between benefits received and the costs bore by the community (Lober and Green, 1994, pg. 34.)

The Roper Organization found that consumers are dissatisfied with alternatives now available (The Roper Organization, 1990, pg. 74.) If people perceive the alternatives as costing more than the current methods, then there will be no desire to change current behaviors. Another problem lies in the perception that there are no correct ways to behave if the problems are beyond the individual's control (The Roper Organization, 1990, pg. 76.) Vining and Ebreo state that people will feel morally obligated to recycle only if they believe that recycling has positive consequences and if they feel personally responsible for the consequences (Vining and Ebreo, 1992, pg. 1585.) However, they feel that Schwartz's norm activation model implies that social norms will only influence behavior indirectly through feelings of obligation (Vining and Ebreo, 1992, pg. 1585.) According to Thøgersen, even though the attitude toward the act is based on moral obligation, perceived behavioral costs act to modify attitudes and behavior (Thøgersen, 1996, pg. 550.)

Lowenthal states that the path by which environmental perception is transformed into behavior needs further analysis. Behavioral alterations of perception involve a system of feedback that calls for concerted effort (Lowenthal, 1972, pg. 334.) Flynn, Slovic, and Mertz refer to perception as a function of trust in institutions and authorities and a disinclination toward giving decision-making power to citizens in areas of risk management (Flynn, Slovic, and Mertz, 1994, pg. 1106.) They discuss perceived control over risks. In the TRA, we have assumed that perceived control is present. Without this assumption, we would be faced with the TPB, which allows for volitional control to be third factor influencing intention, along with attitudes and subjective norms. Bruvold describes perception as dealing with weighing benefits with costs, such as the inconvenience of recycling, sorting the trash, storing the separated materials, extra man-hours involved, etc. (Bruvold, 1973, pg. 215.)

Bacot, Bowen, and Fitzgerald comment that society has long viewed pollution as a serious problem needing attention. Waste carries a strong negative meaning, and since it is considered immoral and immoral is seen as harmful, then waste is perceived as harmful and large amounts of waste are bad (Zeiss and Atwater, 1987, pg. 22.) Negative views of waste have been associated with physical or environmental risks (Bacot, Bowen, and Fitzgerald, 1994, pg. 229.) Perceptions of society are influenced by confidence in management of the problem (Bacot, Bowen, and Fitzgerald, 1994, pg. 230.) When discussing siting of recycling centers, Lober found that public perceptions of risk provided the main motivation for public attitudes (Lober, 1987, pg. 500.)

Vining and Ebreo found behavior was influenced by perceptions regarding the convenience of recycling and beliefs that monetary incentives and rewards are necessary (Vining and Ebreo, 1990, pg. 70.) However, Myers and Halstead suggest the presence of a threshold, where the costs of recycling surpass any moral gains that can be made by recycling (Myers and

Halstead, 1992, pg. 414.) Oskamp and others note that more research should be conducted on trade-offs between environmental concern and other valued goals (Oskamp et al., 1991, pg. 496.)

An apparent break between attitudes and behavior may limit the amount of waste from changing beliefs. For instance, if the public sees industry rather than themselves as the problem, then there will be no feedback that will change their behavior (Scott and Willits, 1994, pg. 240.) This again addresses perceived control. Other hindrances include people being hesitant to change certain aspects of their lives regardless of the cost, lack of sufficient information about how to act in environmentally friendly ways, the absence of strong leadership demonstrating the urgency of needed change, and misperceptions about the concern for the environment due to media coverage or other forms of propaganda (Scott and Willits, 1994, pg. 240-41.)

Pelletier and others state that dissatisfaction with environmental problems is in itself a motivation to action, therefore dissatisfaction can be seen as a determinant of environmentally friendly behaviors such as recycling and purchasing habits (Pelletier et al., 1996, pg. 7.) However, dissatisfaction alone may not be enough to motivate people to action. Therefore, they conclude that other variables may be mediating the influence of satisfaction on pro-environmental behaviors (Pelletier et al., 1996, pg. 23.)

Past Behavior: This section further discusses the concept of past behavior as it helps explain the cyclical nature of the TRA. Past experience may be one of the best predictors of future behavior (Goldenhar and Connell, 1992-93, pg. 100, Bentler and Speckart, 1979, pg. 455.) The concept of feedback implies that personal experience reinforces appropriate behavior, because behavior reinforces experience, which reinforces attitudes deriving from experience, which reinforces behavior, and so on (Vogel, 1996, pg. 603.)

Hamid and Cheng contend that past behavior may be significant in determining future behavior (Hamid and Cheng, 1995, pg. 683.) The TRA starts with beliefs and attitudes and ends in behavior. It is significant only because it may influence current beliefs or attitudes, thus turning the TRA into a closed loop system (Hamid and Cheng, 1995, pg. 684.)

Goldenhar and Connell found that prior experience with behavior may be directly related to intentions and behavior. Prior experience with recycling may affect behavioral intentions to recycle and recycling behavior by the concept of habit (Goldenhar and Connell, 1992-93, pg. 92.)

Ajzen comments that the statement "past behavior is the best predictor of future behavior" will be realized when behavior is stable over time. The factors influencing behavior will be constant (Ajzen , 1991, pg. 202.) However, past behavior may not necessarily be considered a causal factor even though it may reflect factors that influence later behavior (Ajzen, 1991, pg. 203.) Ajzen sums up past behavior by stating that it is best treated as a reflection of all factors that determine behavior rather than a measure of habit (Ajzen , 1991, pg. 203.)

Thøgerson points to the feedback of behavior to beliefs as representative of experience, which will change beliefs. He states that the change may take place soon if expectations were initially exaggerated, or the change may occur later when learning has a chance to make the actions easier (Thøgerson, 1994, pg. 148.) He further states that as personal experience with the behavior is gained, prejudice and skepticism are replaced by knowledge, resulting in the beliefs about the consequences of the behavior and the attitude toward the behavior being adjusted. Alternatively, the learning curve may simply make source separation less troublesome as it is practiced more (Thøgerson, 1994, pg. 154.)

Thøgersen also points out that changes in social norms may initially drive a person to alter their behavior, but as the person performs the behavior, the action may drive changes in their

personal norms (attitudes), which reflects past behavior as influencing the behavioral beliefs (Thøgersen, 1996, pg. 547.)

Attitude-Behavior Inconsistencies: Many inconsistencies with the TRA as well as its causality have been discussed in the literature and will be mentioned here. According to Ehrlich, there must be a clear way for the attitude to be expressed in behavior. It must be able to be expressed, the person must be willing to disclose the attitude, and the perspective of the person committing the act must be similar to the observer (Ehrlich, 1969, pg. 31.)

Ehrlich lists three assumptions when addressing clarity. First, one must learn how to behave in a manner consistent with one's attitudes (Ehrlich, 1969, pg. 32.) Training becomes an important determinant in recycling, because if one does not know how to recycle in a particular community, then no recycling will be done regardless of attitudes or intentions. Second, the opportunity, access to opportunity, or perceived access to the opportunity must exist (Ehrlich, 1969, pg. 32.) If physical barriers to recycling are in place, such as the absence of an agency to collect or reuse the recycled materials, then recycling will not occur regardless of attitudes or intentions. Finally, there must be inferences about behavior that take into consideration differences among individual skill levels and the resources that are available in any given situation (Ehrlich, 1969, pg. 32.) This thesis deals with the average cross-section of a community, which means such variance should not complicate the model. However, on smaller scale predictions, such as an elderly district versus a college district in the same community, there may be differences along these lines.

Other inconsistencies have been attributed to three reasons. First, failure to measure the correct attributes has led to inconsistencies in past research. Second, failure to use a correct

measure of attitudes and behaviors has also led to inconsistencies. Third, not matching the specificity of measures has led to inconsistencies.

As previously mentioned, what is measured must be correct. Attitude toward the object is often measured, but Ajzen and Fishbein found that it is often unrelated to behavior because it fails to influence its predictors, which are attitude toward the act and normative beliefs. The alternative is to measure the attitude toward the act and the normative beliefs directly, rather than measuring the attitude toward the object (Ajzen and Fishbein, 1970, pg. 483.) They felt that this explained why past attempts to predict behaviors from an object by using the attitude toward that object were unsuccessful.

Ehrlich points out that there is consistency between attitudes and behavior only if the normative processes of the groups within which people are acting are consistent (Ehrlich, 1969, pg. 29.) He stresses that low predictions will result from predicting unit behavior from a knowledge of aggregate relations. A better solution, in his opinion, would be to measure attitudes toward a class of people and predict a subject's behavior to some representative sample of that class (Ehrlich, 1969, pg. 29.) Again, this follows the level of specificity that had been discussed by Fishbein and Ajzen (1975, pg. 296.)

Next, the measure itself must be of high quality, or else bad measurements lead to error. In order to reach high attitude-behavior correlations, sophisticated measurement models for attitudes must be used, attitude behavior measures must be high on specificity and conceptual congruency, and the "other variables" that deal with both the person and the situation must be controlled (Ungar, 1994, pg. 291-92.)

Russell Weigel agrees that low correlations may be a result of a poor quality attitude measure (Gray, 1985, pg. 62.) The association between attitude and behavior should improve

when other relevant personal and situational variables are accounted for (Gray, 1985, pg. 65.) He found that to obtain substantial predictive correlations, there must be a high quality attitude measure, and the specificity of the behavior should match the attitude (Gray, 1985, pg. 72.)

In his thesis, Holt suggests that reasons for low to moderate positive relationships may be due to institutional or structural barriers or a lack of personal responsibility. He points to Unger's belief that the weaknesses are due to flaws in the measurement instruments; specifically, the attitude measures fail to measure the most deeply held beliefs concerning the environment, the specific attitudes measured are not associated or linked to specific behaviors, and the existence of confounding issues affect the environmental behaviors (Holt, 1995, pg. 2-10.) He also points to Uusitala's belief that attitude-behavior inconsistencies can be explained by existing information being based on collective, social interests while the decisions are based on the individual utility considerations. Most individuals desire a collective public welfare, and many lack a sense of personal responsibility (Holt, 1995, pg. 2-10,11, Uusitalo, 1990, pg. 223.)

Third, as discussed earlier, specificity in the measure must be the same (Fishbein and Ajzen, 1975, pg. 296.) The more general the intention and the longer the time interval between the intention and the actual behavior, the lower the intention-behavior correlation (Ajzen and Fishbein, 1970, pg. 469.) Goldenhar and Connell cite Stutzman and Green as suggesting that time lags greater than two months result in intentions losing their predictive ability (Goldenhar and Connell, 1992-93, pg. 100.)

Oskamp and others note that a lack of requisite information skills, the amount of personal effort and inconvenience involved, minimal or delayed rewards, and lack of social support or approval for pro-environmental behaviors may explain low correlations between attitudes and behavior (Oskamp et al., 1991, pg. 497.) However, they also conclude that high attitude-behavior

relationships result when the level of specificity is comparable between the two (Oskamp et al., 1991, pg. 516.)

Uusitalo found that inner inconsistencies of attitudes, which refer to attitudes that are inconsistent with each other, leads to attitude-behavior inconsistencies (Uusitalo, 1990, pg. 212.) Correlation between attitudes and behavior will increase as time between attitude and behavior decreases, and as the level of specificity of the behavior increases. It is important to note that if the level of generality is specific enough, then we will have a direct observation of the actual behavior (Gordon, 1969, pg. 250.) This, unfortunately, does not help in the prediction of behavior because the findings become trivial, which means there will always be some error (Uusitalo, 1990, pg. 213.) Vogel concludes by stating that a high degree of specificity not only leads to better results in attitude-behavior relationships, but also in developing management policies (Vogel, 1996, pg. 607.)

The NEP clearly seeks to measure general orientations (Scott and Willits, 1994, pg. 250.) Some researchers have documented the need to measure both attitude and behavior at the same level of generality (Scott and Willits, 1994, pg. 250.) Therefore, the behavior predicted will be of a general nature. One possibility for low attitude-behavior relationships in the past may be due to the lack of a similar level of generality, with specific behaviors being assumed to be valid indexes of a given attitude or a cluster of attitudes leading to an expression of specific behaviors (Scott and Willits, 1994, pg. 254.)

Ehrlich cites Fishbein as saying that because attitude is a hypothetical variable that is influenced by personal beliefs, intentions, and actions toward a given object, there will always be error in the prediction, allowing for low or even negative correlations (Ehrlich, 1969, pg. 30.) He states that reliable predictions of behavior need to come from well formed attitudes or when the

predicted behavior occurs close in time to the attitude measurement (Ehrlich, 1969, pg. 30.) For the best predictions, clarity becomes a key issue.

Finally, there are other problems that confuse the attitude/behavior relationships. Studying individual attitude-behavior links may result in the misrepresentation of structural features and the influence of environmental impacts (Ungar, 1994, pg. 289.) In discussing the attitude-behavior gap, Ungar sites Maloney and Ward as claiming that people state intention to help curb pollution problems, but in fact, "they actually do very little and know even less" (Ungar, 1994, pg. 291.) Also, attempts to change behavior through attitudes do not have appreciable short- or long-term effects. Commitment, modeling, and goal setting strategies appear to be more effective than influencing the attitude-behavior relationship (Ungar, 1994, pg. 291.) Uusitalo lists several factors that affect the attitude-behavior relationship, including different context factors, intentions as a mediating factor, other personal attitudes, and perceived social norms (Uusitalo, 1990, pg. 213.) However, Ajzen and Fishbein account for behavioral intentions and social norms in their model (Ajzen and Fishbein, 1970, pg. 468,) as well as for other various kinds of constraints (Ajzen and Fishbein, 1970, pg. 486.)

Vogel finds that environmental attitude-behavior correlations are low overall and in terms of attitude-behavior correlations in other topics. One reason might be that the highly complex models needed are not being used. Another reason may be the complication of economic factors, such as low cost versus high cost situations. Also, there may be a "free rider" problem due to the public "environmental quality" (Vogel, 1996, pg. 592-93.) Uusitalo found the free-rider syndrome to be complicating factor because there are no incentives to protect the environment, or in this case to reduce solid waste (Uusitalo, 1990, pg. 211.) Finally, Vining and Ebreo cite Newhouse as claiming that explanations for the attitude-behavior inconsistencies include temporal

instability, direct versus indirect experience, normative influences, and attitude-behavior measurement correspondence (Vining and Ebreo, 1992, pg. 1583.)

There may also be barriers to accurate prediction, as discussed by Ehrlich. The first, situational analysis, deals with problems with the structural characteristics of situations, and problems with the social dimensions of situations (Ehrlich, 1969, pg. 32.) The second, multiple-attitude analysis, focuses on the assumption that more than one attitude may be evoked in a given situation, and that the behavior must be determined by the set of attitudes (Ehrlich, 1969, pg. 33.) He states that Triandis has demonstrated that the expression of behavioral intentions varies across the class, gender, ethnicity, occupation, and belief similarity of the attitude (Ehrlich, 1969, pg. 33.) However, as discussed later on in this chapter, only some of these demographic variables consistently predict behaviors. Since we are dealing with the cross section of a community, other variables will be averaged out and will not be significant factors. The assumption of the independence of these variables may not be completely accurate, however, and may require further research.

According to Lutz, numerous studies have reported strong relationships between behavioral beliefs and the attitude toward the act. However, both tests in his studies showed weak results. He suggests that the assumption of a simple linear relationship between cognitive change and attitude change may be an oversimplification. According to Lutz, Rosenberg suggests that an attitude-behavior approach might possibly show up as a "step function" relationship between information and attitudes (Lutz, 1977, pg. 206.) He feels that more evidence pertaining to the strength of the relationship in dynamic situations is needed.

The theory of cognitive dissonance deserves special mention in this section. In his book, Leon Festinger explains the theory of cognitive dissonance. Basically, a person strives toward

consistency between one's beliefs and one's actions. If the person cannot rationalize the inconsistencies or achieve consistency, then there is a psychological discomfort. The existence of this dissonance will motivate a person to try to reduce the inconsistency. When the dissonance is present, the person will actively avoid situations and information that could increase the dissonance (Festinger, 1957, pg. 1-3.) This self regulating process helps moderate behavior to keep them consistent with beliefs. If this is not possible, the person may attempt to change the beliefs themselves (Festinger, 1957, pg. 6,18-19.)

Demographic Variables

This thesis uses seven demographic determinants to help identify the community's desire to reduce waste. The variables are based on literature suggesting these are the most important demographics to consider, although very little is mentioned in the literature about how the demographics are causally linked in the model. Without causality, the determinants are merely correlational, which, although indicates the presence of a link between variables, leaves little insight into the nature of the link. If we are to understand the process, then we must understand the relationships of the components of the process. Simply saying that urban neighborhoods recycle more without understanding that this may be due to the availability of recycling infrastructure or due to the inherent view of the earth that urban dwellers have over rural dwellers may be misleading. Further research into this causality is needed, as addressed in Chapter Five. However, this thesis assumes that the correlational relationships described below are also causal, which is not inconsistent with prior research (Lutz, 1977, pg. 199.)

Ajzen and Fishbein found that external variables, such as attitudes toward targets, personality traits, and demographic characteristics, are sometimes related to behavior. They can either influence the beliefs held or the relative importance attached to attitudinal and normative

considerations. They found that although external factors may indeed influence behavior, there is no necessary relation between any given external variable or behavior, and any affect to behavior will come through the determinants of behavior (Ajzen and Fishbein, 1980, pg. 9.) Also, the external variables are not expected to have consistent affects (Ajzen and Fishbein, 1980, pg. 85.) However, by analyzing the weights attached to certain variables, there may be insights gained into the sources of discrepancies between the model's predictions and the observed results (Lutz, 1977, pg. 203.)

Demographic variables can be global indicators of prior experience (Ajzen and Fishbein, 1980, pg. 90.) Vining and Ebreo state that the overall character of a community may contribute to the extent to which its residents will comply with a recycling program (Vining and Ebreo, 1990, pg. 71.) Uusitalo found that demographic variables, such as gender and age, were better predictors of behavior or intentions than attitudes (Uusitalo, 1990, pg. 223.) Myers and Halstead note that sociodemographic characteristics have been shown to influence recycling behavior (Myers and Halstead, 1992, pg. 412.) However, it is believed that demographic variables can only affect behavior indirectly through their effects on beliefs, motivations, and other internal factors (Guagnano, Stern, and Deitz, 1995, pg. 701, Ajzen and Fishbein, 1970, pg. 468.) Menell claims that knowledge of the demographic variables of the community is necessary to effectively manage solid waste (Menell, 1990, pg. 732.)

In his thesis, Laudenslager found that attitudes concerning the environment vary by gender, education and age (Laudenslager, 1996, pg. 2-14.) He gives a detailed review of the literature on demographic variables and their usefulness as predictors of behavior. However, much of the literature he reviewed dealt with the prediction of behavior from the direct measurement of attitudes, which ignores the causal influences that will drive the differences

between the actual and observed behaviors. Laudenslager points to Gigliotti's description of three fundamental attitudes, which are based on the population density, the needs and desires, or motivation, and the cultural, social, economic, and political structures of the community (Laudenslager, 1995, pg. 2-6, Gigliotti, 1992, pg. 16.)

Laudenslager points to Dunlap and VanLiere, who found demographic variables to be modestly correlated at best and limited in explaining environmental concern (Laudenslager, 1996, pg. 2-7.) According to Laudenslager, Gutteling and Wiegman found that, when dealing with environmental hazards, understanding of the relationship between gender and formal education and reactions to environmental hazards is not complete (Laudenslager, 1996, pg. 2-16.) However, formal education can be important because environmental hazards can be very complex and difficult to understand, where a difference in education level may impact the reaction to the hazard. Women tend to assess environmental hazards as more unacceptable and threatening, and differences in gender may correlate with differences in education level (Laudenslager, 1996, pg. 2-15,16.) Arcury found that age is inversely associated with waste reduction, while education and urban residence are positively associated (Laudenslager, 1995, pg. 2-20, Arcury, 1990, pg. 300.) Ostman and Parker found that education is a good predictor, but wealth may not be (Laudenslager, 1995, pg. 2-21, Ostman and Parker, 1987, pg. 8.) Low income people need a clean environment while high income people want a clean environment.

Schwartz and Miller found that people who engage in pro-environmental consumer behavior stand out because of higher than average levels of education and household income. Many of the most environmentally active Americans have been to college, while many of the least active people have not. Also, women demonstrate more pro-environmental consumer behavior

than men, which is important because women still do most of the household shopping (Schwartz and Miller, 1991, pg. 34.)

Berger notes that the size of residence area, type of dwelling, education, and income are very important determinants of the ability to recycle, which are in turn important to policy makers interested in encouraging recycling behaviors (Berger, 1997, pg. 529.) Oskamp and others found that a higher education level, young age and a liberal political orientation are often correlated with environmental concern, but are still limited in predicting behaviors (Oskamp et al., 1991, pg. 496.)

Arbuthnot found that the best predictors for a recycler include education level, environmental knowledge level, and political ideology (Arbuthnot, 1977, pg. 229.) In his study, he found recyclers to be younger and generally from a high social class, although these two characteristics may not be influencing the recycling behavior. He finds people who are more liberal minded, more flexible in their behaviors and beliefs, and less traditionally oriented are more likely to show pro-environmental behaviors (Arbuthnot, 1977, pg. 230.) This indicates that volitional control, the ability to control events in their lives, is very important to good recycling behavior.

Samdahl and Robertson state that individuals who express the most concern tend to be young and well educated, and urban, with farmers being the least likely to demonstrate environmental concern. However, they point to critics who say that sociobiological cohorts may be more effective than age in predicting environmental concern. Still others claim that the sociodemographic variables may interact in ways not yet understood (Samdahl and Robertson, 1989, pg. 59.) In their study, Samdahl and Robertson found a positive effect of age on environmental concern, which contradicts other studies. Although they feel age effects lie in cohort effects rather than biological maturity, they are uncertain whether older groups of people

reflect the "depression era" ethic of conservation or whether younger groups of people exhibit a more socialized environmental concern (Samdahl and Robertson, 1989, pg. 76.)

Oskamp found that more environmentally concerned people are younger, better educated, and more liberal politically than those who are not concerned. However, in metropolitan areas, the highest levels of concern are found by residents of poor, non-white, high-density neighborhoods that have high levels of solid waste (Oskamp, 1983, pg. 269.) Honnold cites Dunlap and Catton as stating that age, education, political ideology, and residence are the best predictors of environmental concern (Honnold, 1984, pg. 4.)

Arcury states that of the demographic variables, only age, education, urban residence, and political ideology have been consistently correlated with environmental attitude, and that gender, income, and occupational prestige have been weakly or inconsistently correlated (Arcury, 1990, pg. 301.)

Uusitalo found that the young were the least willing to support collective measures in favor of the environment, despite their high general interest in the environment. Their behavior was the least beneficial to the environment (Uusitalo, 1990, pg. 217,) although they were more optimistic about their opportunities to have an effect in environmental matters (Uusitalo, 1990, pg. 220.) It needs to be pointed out that the specificity of this finding is important, especially since these findings are not supported by other authors. The research was conducted in regard to economic growth and satisfaction with personal consumption level. In other words, the measurement tool used may account for the unexpected results. Uusitalo also found that urban people hold attitudes more favorable to the environment, and while past experiences predicted environmentally friendly attitudes, objective, technical knowledge did not (Uusitalo, 1990, pg.

219.) Also, women showed attitudes more favorable to the environment than did men, while education seemed to be less important than found by other authors (Uusitalo, 1990, pg. 220.)

Dunlap and VanLiere (1978, pg. 16) list the most consistent predictors of environmentalism as age, education, and political ideology. However, they state that only the age hypothesis is completely supported from their research (Honnold, 1984, pg. 4.)

Scott and Willits found that consistent predictors of environmental concern have been age, level of education, income, and political ideology, with the young, well-educated, and politically liberal the most environmentally concerned. Gender has been found to be predictive, but not as consistently as the others (Scott and Willits, 1994, pg. 241.) One possibility is that men may express greater support in one area while women express support in another area (Scott and Willits, 1994, pg. 256.)

Van Liere and Dunlap correctly point out that even though the data supports environmentally active people to be young, well-educated, and liberal, environmental concern is by no means restricted to people with such characteristics (Van Liere and Dunlap, 1980, pg. 193.) Oskamp and others state that managers should not assume that environmentally concerned citizens will be likely to recycle (Oskamp et al., 1991, pg. 517.)

As discussed above, there are many demographic variables that may be useful in predicting behavior, although there is no consensus in the literature as to which variables they are. However, the seven used in this thesis will be discussed further below.

Age: Abbott and Harris found age to be significant, with younger people being more radical (Laudenslager, 1995, pg. 2-22, Abott and Harris, 1985-86, pg. 222.) They found that groups under forty years of age accepted the NEP significantly more than groups over forty. This supports Buttel and Flinn's notion that youth tend not to regard as highly the values of the

dominant social paradigm as their parents. It does not mean they completely reject those values. There are two opinions of the aging process. One says that youth have only to age to develop more conservative values. The other says there may be cohort differences among age groups (Abbott and Harris, 1985-86, pg. 226-27.)

Vogel found younger respondents to be more environmentally conscious than their elders only for general attitudes about their environment, but not for any specific attitudes (Vogel, 1996, pg. 599.) Buttel and Flynn found that age was the most strongly and consistently correlated to environmental concern of all the demographic variables (Mohai and Twight, 1987, pg. 799.)

Honnold suggests that aging processes may be important at transitional life cycle stages. Some combination of aging and cohort effects may account for differences between age groups, but changes in environmental attitudes since the early 1970s are probably the result of period effects (Honnold, 1984, pg. 9.)

Van Liere and Dunlap contend that the age hypothesis finds age to be negatively correlated with environmental concern, although some studies have found the opposite (Van Liere and Dunlap, 1980, pg. 189.) However, there are two possible explanations for the findings, which are age group differences and cohort differences. The differences due to the socio-biological process of aging hold that younger people are less set in their ways and are more willing to risk challenging the established social order (Honnold, 1984, pg. 4.) The socio-biological differences may be the result of a changing outlook on society due to biological, psychological, or social changes as people become older (Mohai and Twight, 1987, pg. 799.) These age group differences are differences associated with the aging process and can presumably be outgrown (Van Liere and Dunlap, 1980, pg. 183.) Cohort differences suggest that important historical events occurring at crucial moments of the life cycle, especially the younger stages, can

permanently affect a person (Van Liere and Dunlap, 1980, pg. 183, Honnold, 1984, pg. 4.) The cohort differences also suggest that during the past decade, there has been continued exposure to negative information on the environmental that has affected many young people, forming an ecology-minded generation whose commitment to environmental reform should not disappear anytime soon (Van Liere and Dunlap, 1980, pg. 183.) Attitude differences among people might be the result of differing historical and economic conditions that existed during various periods of time (Mohai and Twight, 1987, pg. 799.) Buttel notes that the environmental movement began during a period of intense generational conflict, which included the Vietnam War and the civil rights movement. Young environmentalists were recruited from the same ranks as those involved in other movements (Mohai and Twight, 1987, pg. 799.) Honnold states that decreases in environmental concern during the 1970s is probably due to period effects rather than socio-biological aging processes or shared historical experiences (Honnold, 1984, pg. 9.) however, Mohai and Twight state that it is difficult to determine exactly why there are differences in environmental attitudes (Mohai and Twight, 1987, pg. 800.)

Political Ideology: Although no significant association has been found between environmental concern and political party identification, there has been a strong association found between measures of liberal ideology and an expression of concern for the environment (Samdahl and Robertson, 1989, pg. 60.)

Van Liere and Dunlap find that political liberals tend to be more supportive of environmental protection than conservatives, but Democrats are no more so than Republicans (Van Liere and Dunlap, 1980, pg. 185.) Therefore they find no support for the party hypothesis but do find support for a liberal-conservative hypothesis with liberals being more environmentally concerned than conservatives (Van Liere and Dunlap, 1980, pg. 192.)

Honnold states that an increasingly conservative political climate may be the cause of a decline in levels of environmental concern, rather than other explanations such as "natural decline" or "ecological backlash"' (Honnold, 1984, pg. 9.)

Income: Liska found that position in social structure may affect people's resources and opportunities to express their attitudes in behavior and to conform to the beliefs of their social referents (Liska, 1984, pg. 70.) However, people in high social classes may simply have more materials to recycle, making the effort seem more worthwhile (Vining and Ebreo, 1990, pg. 59.)

Flynn, Slovic, and Mertz combine racial and ethnic factors with economic vulnerabilities and political weakness such as low income, low levels of education, and other social disadvantages (Flynn, Slovic, and Mertz, 1994, pg. 1104.) Rather than look at race, this model focuses on demographics that characterize racial and ethnic factors, notably income, education level, and location. However, Flynn, Slovic, and Mertz find that these factors are not as influential as perceived control. Those who create, manage, control, and benefit from risk find less of it than those who do not, regardless of the demographics (Flynn, Slovic, and Mertz, 1994, pg. 1106.)

Van Liere and Dunlap combine several demographics into social class, including education, income, and occupational prestige. They note that one explanation for the positive correlations between high social class and high environmental concern is that upper and middle class citizens "have solved their basic material needs and thus are free to focus on the more aesthetic aspects of human existence" which agrees with Maslow's hierarchy of needs theory (Van Liere and Dunlap, 1980, pg. 183.)

In discussing income, Abbott and Harris found that in the context of Maslow's hierarchy of needs theory, those with more money are not more likely to be concerned with higher order

needs such as self-actualization, which might promote development of NEP values. All people, regardless of income, need to care about the environment. At lower orders of need, the environment provides food air and water. At higher orders of need, the environment provides aesthetic good, such as recreation or self accomplishment (Abbott and Harris, 1985-86, pg. 225.)

The Roper Organization found positive correlations between income and environmental concern. Americans were divided into five groups based on environmental concern, with the True-Blue Greens, the most environmentally friendly group, earning on average $32,100 per year, while the Basic Browns, the least environmentally friendly group, earning on average $21,200 per year (Schwartz and Miller, 1991, pg. 29 and 34, The Roper Organization, 1990, pg. 50.) The Roper Organization states that people with higher incomes can afford to make a personal financial contribution to improve the environment. (The Roper Organization, 1990, pg. 50.) Again, in accordance with Maslow's theory, the Roper Organization states that "people who do *not* have, want; those who *have*, want to preserve" (The Roper Organization, 1990, pg. 51.) As evidence, they point to the fact that public concerns about the environment rose dramatically during the 1980s, which was a period of almost unprecedented economic strength. As worries about inflation and unemployment fell, the environment moved up in national attention (The Roper Organization, 1990, pg. 51.)

Although they conclude that the hypothesis that education is positively associated with environmental concern is supported, Van Liere and Dunlap state that the link between income and environmental concern is not clear and does not explain the hypothesized positive association (Van Liere and Dunlap, 1980, pg. 189-90.)

Environmental Knowledge: Gigliotti notes that environmental education is needed more now than ever before, especially when addressing personal behaviors (Gigliotti, 1992, pg. 22.)

Arcury states that it is assumed that increased information leads to increased knowledge about the environment. It is also assumed that increased knowledge is needed to change attitudes. Both knowledge and attitudes are assumed to be needed to change environmental behaviors (Arcury, 1990, pg. 300.)

Ramsey and Rickson note that increased knowledge leads to favorable attitudes concerning the environment, which leads to more favorable environmental behaviors (Ramsey and Rickson, 1976, pg. 10.) Further, they state that attitudes and values do not grow quickly but change slowly over time (Ramsey and Rickson, 1976, pg. 10.) They also suggest that environmental knowledge and attitudes somehow interplay rather than one causing another. Basic knowledge leads to attitudes which in turn motivate one to learn more (Ramsey and Rickson, 1976, pg. 11.) This circularity prevents the understanding of the causality of one variable on the other (Ramsey and Rickson, 1976, pg. 15.) However, we do know that when one is high, the other probably will be also.

Arbuthnot notes that recyclers are generally well informed and knowledgeable about specific environmental issues, are less bound to traditional beliefs and behaviors, and have a strong sense of personal control of behaviors. It appears that educationally oriented information dissemination programs may be successful in changing behaviors. However, the content of public educational programs and appeals for pro-environmental actions need to be tailored to meet the individual needs and concerns of different groups (Arbuthnot, 1977, pg. 231.)

According to Smith-Sebasto, there is considerable confusion and conflicting opinions about which behaviors are environmentally responsible. If the issues are not clarified and appropriate behaviors identified, people will begin to perceive that they are less knowledgeable about and able to behave in an environmentally responsible manner (Smith-Sebasto, 1995, pg.

33.) Further, knowledge of environmental education includes not only understanding the ecological basis for environmental problems, but also understanding the relationship to the cognitive, affective, and conative domains (Smith-Sebasto, 1995, pg. 34.) Environmental knowledge must include an understanding of the effects of recycling and a sense of obligation to recycle (Myers and Halstead, 1992, pg. 413.)

Stapp states that the goal of environmental education is to increase pro-environmental behavior by making society more knowledgeable concerning the environment and its problems as well as skilled and motivated in helping to solve those problems (Larso, Forrest, and Bostian, 1981, pg. 21.)

Pettus contends that basic knowledge of the environment is needed in order to increase pro-environmental attitudes and to enable people to make sound environmental choices (Pettus, 1976, pg. 49.) However, at some point, more formal education and environmental information no longer cause people engage in favorable behaviors, and in some cases may decrease behavior (Pettus, 1976, pg. 50.) Ramsey and Rickson note that knowledge either in favor of or against the environment is likely to lead to moderate rather than extreme positions (Ramsey and Rickson, 1976, pg. 16.) Increased knowledge appears to lead to moderation. Ideally, two opposing forces such as environmental principles and trade-off costs would lead to compromises, especially in a bureaucratic setting, but realistically, educational programs seldom give equal weighting to ecology and trade-off costs because of the bias of the educator (Ramsey and Rickson, 1976, pg. 18.)

In their results, Borden and Schettino found only a minimal degree of association between environmental attitudes and environmental knowledge. They found that increased concern about the environment does not lead to the seeking of knowledge, and that the acquisition of

environmental facts does not result in increased affective reactions (Borden and Schettino, 1979, pg. 38.) One significance of this finding is that people with high attitudes and high environmental knowledge are as likely to be committed to solving environmental problems as other people. Another significance is that environmental knowledge is not needed for individual environmental action. A third significance is that since environmental attitudes and environmental knowledge appear additive, they may be substitutable (Borden and Schettino, 1979, pg. 38.)

Pelletier and others discuss how some people once felt that knowledge about the environment's condition would increase concern for the environment and would be translated into pro-environmental behaviors. However, they found that this was not the case. They believe more research needs to address what the fundamental processes are that underlie environmentally friendly behaviors (Pelletier et al., 1996, pg. 6-7.)

Arcury notes that the causality between environmental knowledge and attitudes has not been resolved in his study. There exists a strong positive correlation of education to both knowledge about and attitude toward the environment, which suggests that knowledge leads to attitudes (Arcury, 1990, pg. 303.) However, the two may actually be highly intercausal, and influenced by other factors (Arcury, 1990, pg. 303.)

Education: Abbott and Harris found that the focus and basis of education are more important than the level of education in the adoption of values. However, values are formed during adolescence and guide the choice and type of education and occupation. Further, socialization, rather than education, plays a substantial role in the development of values (Abbott and Harris, 1985-86, pg. 225.)

Vogel found education to be positively correlated to environmental attitudes in respect to specific variables relating to the special situation in which the respondents lived but not in respect

of the general attitude toward the environment. In other words, Vogel found education to be an intervening variable and indirectly influenced behavior, although there was some direct influence also (Vogel, 1996, pg. 599.) The Roper Organization found a link between education and environmentalism, with college-educated people more likely to be environmentally involved (The Roper Organization, 1990, pg. 53.)

Ostman and Parker note that education is related to information; the greater the amount of education, the greater the amount of environmental information (Ostman and Parker, 1987, pg. 4.) It appears to be useful as a predictor of environmental knowledge and behavior (Ostman and Parker, 1987, pg. 8.) However, Ostman and Parker state that their work gives correlational results and does not address the causality of the relationships between environmental knowledge, concerns and subsequent behavior (Ostman and Parker, 1987, pg. 8.)

Gender: Goldenhar and Connell hypothesize that gender differences in their study would be apparent because adolescent females appear to be more sensitive to and compliant with social demands and may be more susceptible to influence under certain conditions than are adolescent males (Goldenhar and Connell, 1992-93, pg. 93.) Adolescent females may be more susceptible to social pressure from family, friends, and peers. Also, their research suggests that past experience influenced only intentions for females and only behavior for males, while for males, only past experience, and not intentions, influenced behavior (Goldenhar and Connell, 1992-93, pg. 100.)

Many reasons have been suggested as to why women are more concerned about environmental hazards, including their lower personal education level, their maternal instinct to protect their young, and their inherent concern for the environment as opposed to financial profits. Flynn, Slovic and Mertz found that men more often judge risks as smaller and less problematic than women (Flynn, Slovic, and Mertz, 1994, pg. 1101.) They give several

explanations for this. First, women may be more concerned about human health and safety because they are socialized to nurture and maintain life through child birth and rearing. Second, they may be more physically vulnerable in other ways, for example to violence such as rape, and this may sensitize them to risks. Third, women are discouraged from studying science, and there are relatively few women scientists and engineers. This lack of knowledge and familiarity with science and technology may influence perception of risk This results in a distrust of what are perceived as male-dominated technologies (Flynn, Slovic, and Mertz, 1994, pg. 1104.)

The Roper Organization found women to be more environmentally friendly than men. The implications of such a gender gap include women more actively joining environmental groups, women supporting political candidates with an environmental platform, and female office-holders supporting stronger pro-environmental policies. Of main concern is that women still do most of the shopping in America and can influence the environmental condition through consumer behavior, such as buying recycled or recyclable products (The Roper Organization, 1990, pg. 56-57.)

However, Van Liere and Dunlap found no agreement on the gender hypothesis. One suggestion holds that since men are usually more politically active, more involved with community issues, and have higher levels of education, they will be more concerned with environmental problems (Van Liere and Dunlap, 1980, pg. 186.) However, another suggestion is that men are more likely to be concerned about jobs and economic growth, which detracts from environmental concern (Van Liere and Dunlap, 1980, pg. 186.) They find that gender is not substantially associated with environmental concern, but do suggest that more evidence is needed in this area (Van Liere and Dunlap, 1980, pg. 191.) Vogel also found no difference on the basis of gender as far as environmental attitudes were concerned (Vogel, 1996, pg. 599.)

Abbot and Harris found that there are differences between genders, but the differences are not significant (Laudenslager, 1995, pg. 2-15, Abbott and Harris, 1985-86, pg. 226.) Abbott and Harris found that the changing roles of women in western society may account for the lack of difference in attitudes between genders. As women increasingly assume the roles of men in society, their frame of reference becomes more similar to men (Abbott and Harris, 1985-86, pg. 226.)

Location: Although Van Liere and Dunlap find the hypothesis that urban residence is positively related to environmental concern is supported, the association is strongest when local environmental conditions are the focus of attention (Van Liere and Dunlap, 1980, pg. 191, Tremblay and Dunlap, 1978, pg. 479.) Tremblay and Dunlap state that there is a possibility that different levels of concern about the environment between rural and urban communities may result from different attitudes toward nature or different levels of exposure to actual pollution (Tremblay and Dunlap, 1978, pg. 487.)

Dahab and Woldt point out that there are less barriers to waste reduction in large urban areas where markets for recyclable material are available. In rural communities, markets for recyclable material generally are either non-existent or located far away (Dahab and Woldt, 1992, pg. 421.)

Lowe and Pinhey state that urban people see environmental quality as in human control, while rural people view environmental quality as God given and out of human control (Mohai and Twight, 1987, pg. 802.) Of interest, though, is that some researchers found that size of the place where people grew up was more strongly correlated with environmental concern than their current residence (Mohai and Twight, 1987, pg. 802.) This can be rationalized because of the enduring effects on attitudes that early experiences have (Mohai and Twight, 1987, pg. 802.)

Van Liere and Dunlap note that urban residents are more likely to be environmentally concerned than rural residents, with three possible explanations given. First, according to Tremblay and Dunlap, urban residents generally are exposed to higher levels of pollution and other types of environmental deterioration (Van Liere and Dunlap, 1980, pg. 184, Staudt and Harris, 1985, pg. 32, Tremblay and Dunlap, 1978, pg. 475.) Next, Tremblay and Dunlap suggest that rural residents usually have utilitarian view of nature (Van Liere and Dunlap, 1980, pg. 184, Tremblay and Dunlap, 1978, pg. 476.) This utilitarian view may result from direct involvement with occupations in the natural environment, such as farming, logging, or mining (Staudt and Harris, 1985, pg. 32.) People dependent on these types of occupations usually believe in using nature rather than just appreciating it. Such attitudes are associated with less concern for environmental quality (Tremblay and Dunlap, 1978, pg. 477.) Also, because of the shared rural culture, it can be expected that a utilitarian perspective would be prevalent among rural residents (Tremblay and Dunlap, 1978, pg. 477.) Finally, Murdock and Schriner suggest a third explanation. Small towns value growth over protection of the environment because they need to maintain economic growth to survive (Van Liere and Dunlap, 1980, pg. 185, Staudt and Harris, 1985, pg. 32.)

External Influences

Tracy and Oskamp stress that the determinants of behaviors are not only internal characteristics, but also external factors. In order for change in behavior to occur, management policy will need to be directed towards these external factors (Tracy and Oskamp, 1983-84, pg. 124.) The first three external influences to be discussed (barriers to behavior, incentives, and legislation) affect behavior directly, while the fourth (training) affects behavior indirectly through the behavioral beliefs.

However, there may be other external influences in a real-world system. For instance, Thøgerson describes his theory in terms of motivation, which also includes beliefs, attitudes, social norms, and intentions (Thøgerson, 1994, pg. 147.) He also includes as external variables the concepts of ability and opportunity (Thøgerson, 1994, pg. 147.) Thøgerson points to many examples of previous research that find habit to be independent of intentions, but mentions that neither habit nor its influence behavior are well documented (Thøgerson, 1994, pg. 155.) Opportunity, on the other hand, can be subjective, such as perceived control, or it can be objective, such as facilitating preconditions for the behavior (Thøgerson, 1994, pg. 147.) Either way, intentions about source separations may be violated due to a lack of opportunity. In this light, opportunity can be viewed as physical barriers, whether or the not the barriers are real or perceived.

As for other forms of external influences, Allaway discusses external sources of change, such as climate, employment and disposable income (Allaway, 1992, pg. 61.) There may be no end as to what could be an external influence in the long term. However, this thesis limits the external influences to the four previously mentioned.

Barriers to Behavior: Barriers to behavior are any factors that prevent an intention from becoming an action. Examples can be physical, such as lack of infrastructure to support a recycling operation, or mental, including lack of knowledge or skill to recycle. Note, however, that some forms of barriers fall under multiple influences, such as lack of knowledge being addressed by knowledge. Growth and technology can even be impediments to reduction of waste (Laudenslager, 1995, pg. 2-6, Gigliotti, 1992, pg. 23.) Myers and Halstead suggest that perceived barriers, such as lack of time, no information, and failure of the municipality to provide a curbside pickup, can influence recycling behavior (Myers and Halstead, 1992, pg. 412.)

Levenson states that one of the key barriers to recycling is the dynamic nature of markets for recovered materials. Some materials are not recycled because they are demand limited. Markets will always exist, but they will also fluctuate in terms of demand (Levenson, 1993, pg. 32.) Such barriers will hinder behavior even if attitudes about recycling are high. Increasing recycling behavior is irrelevant if there is no demand for products made from recyclable materials (Porter, Leeming, and Dwyer, 1995, pg. 149.) If there is no way to dispose of recyclable material other than landfilling, then no material will be recycled regardless of beliefs, attitudes, and intentions.

Berger found that access to recycling services mediated the influence of socioeconomic and demographic variables on recycling behavior. Many people will engage in pro-environmental behaviors if they have a convenient way of doing so (Bentler, 1997, pg. 524.) This finding is slightly different from physical barriers to behavior because different social classes will have different barriers placed on them. However, removing the barriers from recycling (making recycling accessible) by possibly increasing its visibility may create a context in which recycling becomes a social norm. This social norm may in turn promote other environmentally responsible behaviors (Berger, 1997, pg. 525.)

Larson points out that economic constraints must be considered when determining what type and level of diversion activity is appropriate (Larson, 1993, pg. 5.) Oskamp and others suggest that the inconvenience of storing and transporting materials to a recycling center can create a barrier to recycling behavior, but curbside recycling should reduce this problem as noted in the increase in the amount of recycling (Oskamp et al., 1991, pg. 499.)

Incentives: Incentives work to override intentions. Despite what a person intends to do, if the person gets a better offer, such as money for recyclable material, the person will typically take the better offer, providing the incentive outweighs any strong belief to the contrary.

Bacot, Bowen and Fitzgerald credit Geller, Winett, and Everatt as stating that strategies for modifying behaviors are based on the consequences involved, which are either pleasant (positive reinforcers) or unpleasant (negative reinforcers or punishment) (Bacot, Bowen, and Fitzgerald, 1994, pg. 231.) While external factors such as incentives may be effective at initiating behavior, sustained participation requires intrinsic motivation (Guagnano, Stern, and Deitz, 1995, pg. 706.)

Governmental policies often stress the use of penalty strategies to manage behavior. This may be because, compared with reward strategies, they are relatively inexpensive and can be a very effective behavior-management technique (Potter, Dwyer, and Leeming, 1995. Pg. 197.)

Vining and Ebreo state that persistent forms of incentives or rewards will be more likely to effect long-term behavior changes (Vining and Ebreo, 1990, pg. 72.) Myers and Halstead cite Wysopal as suggesting that providing an economic incentive is the most effective way to influence household recycling behavior (Myers and Halstead, 1992, pg. 412.) According to Borden, incentives for newspaper recycling were found to produce the largest effects compared to other types of manipulation in two studies (Gray, 1985, pg. 177.)

Oskamp found that monetary incentives were successful reinforcers in energy conservation research. However, monetary incentives can be costly. Other approaches have been suggested that use partial reinforcement procedures such as reinforcement of a random sample of participants, or contests or lotteries to determine the winners from a group with successful behaviors (Oskamp, 1983, pg. 273.) Further, punishments such as fines or penalties are usually

less successful in influencing long-term behavior (Oskamp, 1983, pg. 274.) It is therefore interesting that government policies rely on penalties when societies prefer incentive approaches over coercive or regulative approaches (Oskamp, 1983, pg. 274.)

Thøgersen adds that there were many earlier recycling programs in the United States and Europe that were based on economic incentives, either as deposits or as payments for materials (Thøgersen, 1996, pg. 541.) However monetary rewards can have a negative impact on intrinsic motivation (Thøgersen, 1996, pg. 542.)

Legislation: Legislation also acts to override intentions. However, in America, legislation has typically been used as a negative incentive because of the tendency to punish behaviors that are harmful to the environment.

A typical community will have very little effect over state or national environmental laws; therefore these can be seen as a constant. Local laws, however, should be reflective of the communities' general attitudes toward the problem of waste. There will be a delay between the time a problem is perceived and when the laws will be enacted. Because of this delay, there will be a time when too many laws are enacted, because results from new laws will not be seen right away. As a result, Borden found that in some cases, legislation can produce a 100% change in behavior (Gray, 1985, pg. 178.)

According to Alig, legislation aimed at preserving natural resources through source reduction and recycling have altered the traditional competitive marketplace (Alig, 1993, pg. 95.) State laws enacted since 1987 for all solid-waste management issues have been focused on altering people's behaviors (Alig, 1993, pg. 95.) Many times, the legislation was successful (Schwartz and Miller, 1991, pg. 29.) Court systems can be viewed as institutions that attempt to promote behavioral change through the enforcement of legislation aimed at applying penalties to

inappropriate behaviors (Potter, Dwyer, and Leeming, 1995, pg. 197.) Laws that mandate recycling will increase recycling behavior of a community, regardless of education or personal differences within that community (Porter, Leeming, and Dwyer, 1995, pg. 149.)

Legislation can also be viewed in other ways. Different types of laws can be used to influence behavior in various ways. For instance, Menell suggests that laws can be used to mandate education programs, require bins for separated materials, and encourage a community spirit of conservation (Menell, 1990, pg. 733.) By mandating behaviors, the laws will influence behavioral and social beliefs rather than just mediate intentions directly.

Lober and Green comment that people often are opposed to policy solutions by outsiders such as state and federal governments (Lober and Green, 1994, pg. 47.) The Roper Organization found that recycling is not purely voluntary on the part of society because legislation is requiring that materials be recycled. The laws stimulated the changes in behavior (The Roper Organization, 1990, pg. 67.)

However, Dunlap states that many more important changes must be made within political and economic institutions as well as in individual behavior if more changes to behavior are to occur (Dunlap, 1991, pg. 309.)

Dunlap and Scarce found that government regulations have not gone far enough and more government regulation is needed in the area of environmental protection. Further, people believe that more must be done to solve solid waste problems, even when focusing attention on specific restrictions to individual behavior (Dunlap and Scarce, 1991, pg. 655.)

Training: Training differs from the other three external variables in that it influences behavioral beliefs rather than the behaviors themselves.

According to Tchobanoglous and others, people must be willing to change on their own if significant reductions in the quantities of solid wastes generated are to occur. A program of continuing education is necessary to bring about this change in public attitudes (Tchobanoglous et al., 1993, pg. 143.)

Oskamp and others note that a lack of knowledge regarding how to recycle presented a considerable barrier to recycling behavior (Oskamp et al., 1991, pg. 499.) Studies have found that persuasive campaigns have affected recycling rates (Oskamp et al., 1991, pg. 514, Bacot, Bowen, and Fitzgerald, 1994, pg. 240.) However, Gigliotti states that training has reached groups like industry but has not reached individuals, nor has it affected their roles (Gigliotti, 1992, pg. 23.)

Dahab and Woldt conclude by stating that a real pollution prevention ethic and behavior change can only be achieved through education targeted to specific types of waste generators. This effort needs to be focused and individualized to each generator (Dahab and Woldt, 1992, pg. 429.) No single approach will work on every generator of solid waste.

Allaway notes that personalized education has one of the greatest short-term diversion potentials among source reduction options (Allaway, 1992, pg. 61.) Managers need to develop literature which identifies the positive benefits of recycling rather than stressing the convenience of the program (Bennett, 1990, pg. 83.) In other words, proper training must adjust the underlying values rather than attempt to alter behavior directly if sustained changes are to occur.

Culen et al. stress that an educational strategy of generating interest and providing appropriate skills should be useful in establishing a pro-environmental society (Culen et al., 1986, pg. 31.) In other words, if a community wants its citizens to recycle, it must motivate them to recycle as well as instruct them in how to recycle.

Tracy and Oskamp state that people need to know which behaviors are not ecologically responsible and which behaviors should be performed (Tracy and Oskamp, 1983-84, pg. 123.) Gigliotti states that people do not automatically make personal sacrifices. Therefore, the educational message must be specific in order to encourage the proper behavior (Gigliotti, 1992, pg. 23.) De Young points out that managers cannot assume that once the community knows why to recycle, they will know how to recycle (De Young, 1988-89, pg. 349-50.) In fact, De Young asserts that people will avoid attempting an activity regardless of attitudes if they do not know how to do it. Therefore resource recovery education programs should focus on how to reduce waste rather than why (De Young, 1988-89, pg. 350.)

Vining and Ebreo found that recyclers were more often better informed overall about recycling than nonrecyclers. They had more accurate knowledge about locally recyclable materials, and they were familiar with more local programs and sources of information (Vining and Ebreo, 1990, pg. 68.) Not only are increased educational efforts needed, but research needs to address why nonrecyclers possibly discard or discount information that is contrary to their current behavior (Vining and Ebreo, 1990, pg. 68.) If incoming information agrees with current beliefs, but not with behavior, then either the behavior must change to match the belief, or the information must be ignored (Vining and Ebreo, 1990, pg. 68.)

In his conclusion, Thøgerson states that behavior is ultimately explained by information, and that this information is a means to change behavior. However, he also stresses that management of the physical conditions is equally important (Thøgerson, 1994, pg. 159.) The initial informational campaign should resemble an educational program rather than an awareness program. It should focus on how to perform the behavior rather than why. A long term goal is to

make the desired behavior habitual, where people do it correctly consistently and with little effort (Thøgerson, 1994, pg. 160.)

In terms of continuing education, the Roper Organization found that 75% of Americans claim TV news is a major source of information, followed by newspaper (65%) and TV news magazine programs (61%) (The Roper Organization, 1990, pg. 53.) Honnold states that aggressive adult and community-oriented environmental education efforts are potentially important (Honnold, 1984, pg. 9.)

Oskamp comments that information campaigns by managers are very popular to influence behavior. However, when studied with careful scientific methods, they have rarely had any effect on people's behaviors. It is quite possible that long-continued information campaigns do have cumulative effects, but they may not be successful unless conducted as part of a larger conservation program (Oskamp, 1983, pg. 271-72.)

System Dynamics Review

The previous background describes a system that is complex and dynamic, with changes occurring over time and complexity arising from the interactions of the system, including the external factors on the system. Simulation is appropriate when the desire is to experiment with and study the internal interactions of such a complex system. Simulation will help investigate the effects of changes to the external influences on the system. Simulation is also valuable in learning what variables are important in the system and in experimenting with possible scenarios to produce favorable responses from the system. In other words, model simulation fits the needs of this thesis effort as described in the research questions.

A system dynamics approach to simulation is best suited to gain understanding of such a system. The complex interactions which tend to confuse people when approached collectively are

easily controlled and analyzed in a system dynamics modeling effort. People seldom visualize the feedback loops, multiple and non-linear interactions, and time constraints on a real world system. A system dynamics model is well-equipped to reduce the unwieldy real world system to its basic components. The system dynamics process strives to understand the mechanisms that drive the system. Once realized, the system can then easily be altered to explore possible real world scenarios and alternatives that will provide the desired response from the real world system. The system dynamics system is iterative and requires client interaction at each junction to ensure an accurate and mechanistic representation of the real world system. For these reasons, a system dynamics approach is utilized to address the questions posed in Chapter One.

According to Vennix, Akkermans, and Rouwette, system dynamics has recently evolved into a well accepted method to support strategic decision making. Its objective is to enhance understanding of the system's response and to test policies that will give the desired response to problems in question (Vennix, Akkermans, and Rouwette, 1996, pg. 39.) Vennix, Akkermans, and Rouwette focused their study on the problem of changing attitudes and behavior. They discuss the TPB, which is described as "a well-known contemporary social pyschological theory that explains and predicts behavior" When viewed in a system dynamics context, they state that solely changing knowledge about a problem is not sufficient to alter behavior (Vennix,

Morecroft suggests that increasingly system dynamicists are viewing their models as "sources of new knowledge." The models are used as learning tools when applied to social systems (Morecroft, 1988, 310.) Ideas taken from behavioral decision theory are being used in modeling in the academic community, and are stimulating new research in the experimental study of organizational decision-making (Morecroft, 1988, 308.) Morecroft cites Wolstenholme and Coyle as stating that "qualitative" modeling, or modeling traditionally non-quantified systems, is

useful to managers when the modeler uses the symbols and structuring rules of system dynamics creatively (Morecroft, 1988, 308-09.)

Vásquez, Liz, and Aracil refer to three kinds of knowledge that lead to a mental understanding of the system under study when building system dynamics models. The first, structural knowledge, comes from available theoretical knowledge, and is expressed with the help of scientific concepts or as intuitive terms and in ordinary language (Vásquez, Liz, and Aracil, 1996, pg. 24.) The second, quantitative knowledge, is stated verbal descriptions of system response, time series, or empirical behaviors and in the mental understanding of initial values of the variables in the real world system (Vásquez, Liz, and Aracil, 1996, pg. 24.) The expected response of the system forms the reference mode, which will be discussed again in Chapter Three. The third, operational knowledge, is the specific system dynamics skills and practical knowledge that the modeler uses when integrating the other two kinds of knowledge, which results in the system dynamics model. The model simulates the expected behavior of the system under study (Vásquez, Liz, and Aracil, 1996, pg. 24.)

In describing the system dynamics approach, Morecroft highlights three areas which incorporate the conceptualization and testing of the final product as discussed in detail in Chapter Three. First, an a priori expectation of system behavior, or the reference mode, must be established (Morecroft, 1988, 311.) Second, follow up all behavior that does not correspond to the reference mode (Morecroft, 1988, 311.) Finally, confirm all hypotheses about surprise dynamic behavior by explaining the behavior with appropriate model tests (Morecroft, 1988, 311.)

In terms of testing, Vásquez, Liz, and Aracil note that there is a difference between purely correlational or statistical models and system dynamics models. System dynamics models are

used in forecasting and control, as are statistical models, but they also try to offer explanations and understanding (Vásquez, Liz, and Aracil, 1996, pg. 21.) They must have the most realistic content possible in order to provide explanations and understanding (Vásquez, Liz, and Aracil, 1996, pg. 27.) Identifying the basic mechanism or structure that brings about the behavior is required because that structure will guide the model building process. Without identifying the basic structure and establishing an expected system response, there is no basis from which to evaluate simulations of the system (Vásquez, Liz, and Aracil, 1996, pg. 28.) Therefore, no knowledge can be gained from the results.

Morecroft describes several advances in system dynamics in the 1980s that have made the subject more accessible to policymakers, more communicable to the academic community, and more challenging for research. For instance, there have been improvements in the software used to map and model system structure, there have been improvements in analyzing simulation results allowing for better insight into dynamic behavior, and there has been more emphasis placed on dialogue between reference modes and computer simulation models (Morecroft, 1988, 302.) Morecroft credits Forrester with reshaping sophisticated modeling and analysis methods from control engineering into a form usable in the business/social arena. This reshaping has lead to new software that allows for the ability to map knowledge of systems into algebra and differential equations (Morecroft, 1988, 303.) Advances in graphic computers have made it possible to map symbols directly onto a computer screen. This ability results in quickly obtained and understandable output. The modeling and simulation package STELLA II ® includes very effective mapping software and is utilized in this thesis effort. The software is designed to constrain modelers to produce diagrams which connect symbols in the proper sequence. It

provides a very effective means for mapping knowledge of a business or social system and make the diagram and mathematics easy to understand (Morecroft, 1988, 304-05.)

Summary

The TRA according to Fishbein and Ajzen, states that behaviors are caused by intentions, intentions are caused by attitudes and subjective norms, and attitudes and subjective norms are caused by behavioral and social beliefs. However, through perception and past behavior, beliefs are influenced by the behaviors. Behaviors are altered by external influences such as barriers to behavior, incentives, and legislation, while behavioral beliefs are altered by training. Demographics influence the social beliefs of the community, with the NEP being a reflection of those beliefs. Although there is no consensus among researchers, the most popular demographic predictors of a community's desire to reduce waste are age, political ideology, income, environmental knowledge, education, gender, and location, such that a young, liberal, wealthy, college educated, urban female with high environmental knowledge is the most likely to hold beliefs in favor of protecting and conserving the environment.

Chapter 3
Methodology

Introduction

As discussed at the end of Chapter Two, a system dynamics approach is relevant when addressing the factors surrounding the generation and reduction of solid waste from a behavioral standpoint. This chapter will now discuss the methodology distinct to this thesis effort. Specifically, it will address how the system dynamics approach will be utilized. To do this, the areas of conceptualization, model formulation, testing, and implementation will be discussed as they relate to this thesis. Chapter Four will detail the same areas, specifically addressing the results of each step discussed in this chapter.

Conceptualization

The initial step is the identification of a problem. To properly identify a problem, knowledge must be gained about the specific system. An extensive literature review combined with interaction with people in the field is the best method to gain understanding. The literature review and client interaction are continual; as more knowledge is gained, more areas needing attention will be identified. However, once the bulk of the knowledge is gained, the problem can be clearly stated and the specific questions to be addressed can be formulated. This initial review of the problem and the system surrounding it will usually indicate possible means for solving the problem.

With the initial understanding of the system and a basic knowledge of how it operates in place, a statement of the problem can be made, as well as specific questions to address. Next, a reference mode can be formulated based on the information review. The reference mode represents the expected response of the system, including a mental picture of the outcome of the

system. This reference mode identifies how the system will respond over the time period of interest. It is created using a set of sentences and graphical illustrations that describe the interaction among variables in the system and between the internal and external players of the system. The description also explains qualitatively how variables influence each other over time (Vásquez, Liz, and Aracil, 1996, pg. 25.)

This mental conception of the system and how it operates is not to be taken lightly. Vásquez, Liz, and Aracil list three important attributes about reference modes; they are not fixed, they are not simple, and the structural information that they provide about certain systems is usually reliable. The models are very interactive and provide a very insightful representation of the structure of the system. If the background review is extensive enough, the reference mode will be very reliable and will not change much throughout later iterations of the model development (Vásquez, Liz, and Aracil, 1996, pg. 25.) The reliability of the reference mode is necessary because it will guide the formulation of the system structure and, subsequently, the model structure.

After the system is researched and a basic understanding of how the system operates is achieved, the causal relationships of the system need to be identified. The best method of achieving this is through the use of the influence diagram. All the relevant factors are listed. Then the components are connected with lines, indicating influences between the components. At this point, circular relationships will develop. These closed loops are characteristic of the system dynamics approach. It is these relationships that create the complexity of a system.

Once the lines are drawn, the direction of the influence can be determined. For each line, the question is asked, "If Variable A is increased, will Variable B respond?" If the answer is yes, then an arrow is drawn pointing from Variable A to Variable B. If a positive change in Variable

A leads to a positive change in Variable B, then the arrow is labeled with a plus sign. If the change to Variable B is negative, then the arrow is labeled with a minus sign. If there is no change, then there is no influence and the line can be erased.

This process is also iterative. Once there is a basic understanding of the system and the problem is identified, a top level or initial influence diagram can be drawn. This diagram is usually broader in scope and does not list all of the variables that comprise the system. Later successional diagrams will include such variables. The important thing here is to recreate a representation of the primary structure that will produce the reference mode, rather than create a confusing diagram that tries to represent the real world system before complete understanding is gained. The basic information review is completed, but some processes or interactions may not be understood at this time. The initial diagram can aid in identifying what needs clarification. The initial diagram, through many iterations, will help guide the construction of the "final" model that will be used to construct the model. Even this "final" diagram is not necessarily final.

Model Formulation

The completed influence diagram is significant in its usefulness in coding the system into a mathematical model. Once it is finalized through successive iterations of research and customer critique, which is accomplished through periodic committee meetings and interaction with committee members, the influence diagram will be converted to a flow diagram, which illustrates how the components of the system will interact. The coding will be done using STELLA II ®, a software package from High Performance Systems, Inc., that is designed to create and analyze flow diagrams.

In the flow diagram, each variable will be identified as a stock, a flow, or a converter. A stock is an entity that can be counted. It can increase or decrease in quantity based on the flow

into or out of it. The flows are defined by the converters, or variables that represent a constant value or a mathematical relationship of several converters. Converters can influence each other or the flows. The flows can influence the stocks or the converters. The stocks can influence the flows or the converters. Once the flow diagram, or the model structure, is complete, then all of the components will need to be given values. For the stocks, the values are only initial. The value of the stocks will change as the model progresses through time. The constants, however, will not change over time.

As the model is being constructed, certain aspects of the testing, to be discussed below, will begin to be used. The testing process is not a successive operation that follows the model formulation, but rather an integral part of the model formulation. The tests are used for "de-bugging" the model as it is built. It is also used to test the structure adequacy and usefulness. The testing will tell us if the model is sufficient to represent the real world, or if more or less structure is needed to accurately portray the system we are trying to study. For clarity, however, the tests will be discussed separately in the next section.

Testing

Testing is significant in that it can show that the model is useful for its intended purpose. Statistical models tend to give empirical data that fits real world data, and several mathematical tests can be used to show that the results "fit" the original data, or come from a source similar to the real system. System dynamics models look not as much at empirical data but at behavioral responses to the system to see if the response is similar to a real world response. However, the model must be comparable to "empirical reality" for the model to be seen as valid (Forrester and Senge, 1980, pg. 210.) Forrester and Senge describe validation as 'the process of establishing confidence in the soundness and usefulness of a model' (Forrester and Senge, 1980, pg. 210.)

This validation is achieved by gaining confidence through successive tests that produce results comparable to the real world (Forrester and Senge, 1980, pg. 210.)

Forrester and Senge found no single test which can "validate" a system dynamics model. Confidence in the model comes gradually from applying successive tests to the model and obtaining results that correspond well with the real system (Forrester and Senge, 1980, pg. 209.) As each test is completed, the model is compared with the empirical or expected results. If the results are comparable, or evidence to prove the model incorrect is not found, then the model is given credence (Forrester and Senge, 1980, pg. 211.) Such tests of model structure and behavior cannot necessarily be performed with other types of statistical tests. In fact, some statistical tests are not valid with this type of simulation (Forrester and Senge, 1980, pg. 209.)

The most important aspect of testing is building confidence in the model. If the modeler cannot build that confidence and impart it on the potential users of the model, the model will not be of value. Without confidence in the model, it cannot be used to test possible scenarios that are designed to obtain favorable responses from the system (Forrester and Senge, 1980, pg. 210.)

Forrester and Senge list seventeen tests of model structure, behavior, and policy implications. However, they list only ten as the "core tests for systems dynamics," which are the basic subset that system dynamicists usually agree on (Forrester and Senge, 1980, pg. 226.) This list would include all of the structure tests discussed below, the behavior-reproduction tests, the behavior anomaly test, the behavior-sensitivity test, the changed-behavior prediction test, and the policy-sensitivity test (Forrester and Senge, 1980, pg. 226.) All of the tests described by Forrester and Senge will be described below, and grouped according to test type, beginning with tests of model structure, then with tests of model behavior, and finally ending with tests of policy implications. The tests will be described and the purpose for the tests will be explained here.

Chapter Four will illustrate the specific results of each test on this model, outline what the results mean, and discuss the response taken, if any, following each test. It is important to note that if the response to a test is to change the model, previous tests become invalid and need to be retaken. The testing process is therefore iterative. However, most of the iterations come during the actual building of the model, during which some of the tests will be conducted informally as the model is constructed.

Tests of the model structure: The tests of the model structure look directly at the structure and parameter values to ensure compatibility with the real world (Forrester and Senge, 1980, pg. 212.) The relationships between structure and response of the model are not included here, but is covered under the tests of model behavior, to be discussed next. There are five tests discussed here, which include the structure-verification test, the parameter-verification test, the extreme-conditions test, the boundary adequacy (structure) test, and the dimensional-consistency test.

1. Structure-verification test: The structure verification test compares the model structure with that found in the real world and in the literature reviewed. Client interaction is also valuable in verifying the structure. This test verifies that the real world system is accurately portrayed in the model. Model assumptions are also compared to descriptions of various relationships found in the knowledge review of the system (Forrester and Senge, 1980, pg. 212.) In order to pass the test, there must be no contradiction in knowledge between the real world system and the model (Forrester and Senge, 1980, pg. 212.) The test is iterative throughout the construction of the model. It must be completed not only by the modeler, but also by the clients and experts in the field (Forrester and Senge, 1980, pg. 212.)

2. Parameter-verification test: This test is similar to the structure verification test in that the parameters used are checked to ensure compatibility with the real world system. Again, this is done through an iterative process of literature review and client interaction. The parameters must correspond both conceptually and numerically to the real world system in the time frame of interest (Forrester and Senge, 1980, pg. 212.) Both the structure verification and parameter verification are necessary in order to ensure the model describes the real system (Forrester and Senge, 1980, pg. 212.)

3. Extreme-conditions test: This test checks the models response when extreme values of the variables are used. The extreme values should correspond to real world extreme values and the response should be plausible under real world conditions. This test checks for flaws in the model as well as checks for missing variables (Forrester and Senge, 1980, pg. 214.) Knowing that the model is accurate at its extreme conditions makes the model useful outside the range of the empirical data that may have only been gathered in a small section of the range of the model representing the normal operating region (Forrester and Senge, 1980, pg. 213-214.) If the test is not passed, then there is a flaw in the structure, not necessarily in the values of the extreme conditions. If the extreme values occur in real life, then the structure must be checked for accuracy (Forrester and Senge, 1980, pg. 213.)

4. Boundary adequacy (structure) test: The structure boundary adequacy test ensures that the model accurately includes all structure necessary to represent the real world system of interest without adding so much detail that it does not aid in gathering understanding of the system. The model is again checked against the literature and client understanding to verify structure boundary adequacy. Also, the model structural boundary must be weighed against the model purpose. Forrester and Senge note that criticisms of the structure boundary usually stem

from a misunderstanding of the purpose of the model (Forrester and Senge, 1980, pg. 214-15.) Excess structure in this case may include influences from lunar cycles on behavior, which represents a possible but extremely improbable influence on the system. The structure may be accurate but unnecessary to achieve the desired purpose. If, however, more structure is needed and is subsequently added, previous tests may need to be retaken. This shows that even the testing process is dynamic when using system dynamics models.

5. Dimensional-consistency test: This test checks the dimensionality of the model's variables. If the model has "scaling parameters" that have no meaning other than to rescale values to expected value ranges, the test is not passed (Forrester and Senge, 1980, pg. 216.) If variables must be rescaled to be useful, there may be structure or variables missing. Therefore this test is useful when applied with the parameter verification test (Forrester and Senge, 1980, pg. 216.) The parameter values should be correct. If they are and the dimensional consistency test still fails, their may be other problems to solve.

Tests of model behavior: These tests are used to check the response of the system, which is not to be confused with the behavior entity represented in this model. The behavior tests check the model structure by analyzing the response of the system (Forrester and Senge, 1980, pg. 217.) If the response is not correct, there may be a problem with the structure of the model. Therefore it is important to repeat any tests of model structure if results of tests of model behavior lead to changes in the model. There are eight tests discussed in this section, including the behavior reproduction tests, the behavior prediction tests, the behavior anomaly test, the family member test, the surprise behavior test, the extreme policy test, the boundary adequacy (behavior) test, and the behavior sensitivity test.

6. Behavior-reproduction tests: These tests determine if the behavior is a result of the model structure or if external influences are added to mimic the system behavior. For instance, are pulses or step inputs to parameter values used to generate patterns noted in the real world system behavior? If so, the model structure may again be inadequate and changes should be made. The model results are more meaningful when certain features of the response are dictated by the model structure rather than parameter inputs (Forrester and Senge, 1980, pg. 219.)

a. Symptom-generation test: This test checks to see if a problem noted in the real world response is seen in the model response. Since the use of a model is to analyze undesirable outcomes in the hopes of preventing them, then the model must be able to recreate those undesirable outcomes (Forrester and Senge, 1980, pg. 217.)

b. Frequency-generation test and relative phasing test: These tests address the cyclic responses between the variables of the model. Again, real world cycles need to be recreated in order to fully address analyzing and potentially altering the response of the system (Forrester and Senge, 1980, pg. 217.)

c. Multiple-mode test: This test checks to see if different modes of response can be generated by the model. If different response cycles are overlapped or if one cycle changes into another cycle, then the model should be able to reproduce these results. Again, the model must be able to recreate real world cycles in order to be useful when testing different scenarios that are desired to alter the system response (Forrester and Senge, 1980, pg. 218.)

d. Behavior-characteristics tests: This test checks for special peculiarities in the model response that will correspond to the real world response. The various shapes present in the actual data may be caused by random fluctuations in the system which produce an oscillation in a

damped system (Forrester and Senge, 1980, pg. 219.) Reproducing these behaviors without specifically adding the changed values non-randomly verifies the accuracy of the model structure.

7. Behavior-prediction tests: Behavior prediction tests are used to predict future responses to the system. The responses are not specifically "point predictions" but rather the general response of the variables in the system (Forrester and Senge, 1980, pg. 219.) The model should be able to give realistic response past the known real world data. The responses should be a result of the structure of the model.

a. Pattern-prediction test: This test checks to see if the model gives correct patterns of future responses (Forrester and Senge, 1980, pg. 219-20.) Such a test is helpful in determining if the model can be used to produce useful results when testing scenarios.

b. Event-prediction test: This test is similar to the pattern prediction test, but focuses on specific events in the model response. These events are similar the events discussed in the behavior reproduction tests, but are found in the model's response in the future. The events do not need to be specific events at a precise time in the future, but rather on the dynamic nature of the event (Forrester and Senge, 1980, pg. 220.) Again, being able to accurately predict future events gives credence to the utility of the model.

8. Behavior-anomaly test: This test checks for such anomalies as variable values changing erratically or not changing at all. Once erratic behavior is identified, it must be explained. Sometimes the explanation is simple, such as a poor time period between calculations in the model program itself. Other times the problem is not easily recognized. The problem may lie in the model structure, which may not be adequate to represent the true mechanisms of the system (Forrester and Senge, 1980, pg. 220.) Finally, using the test by altering the assumptions

and getting implausible responses gives verification to the original responses (Forrester and Senge, 1980, pg. 220.)

9. Family-member test: Very often there is a general class of systems, of which the model being tested is one. The family member test compares the model to a general class of systems. The model structure should therefore correspond to the structure of the general class of systems. Differences in the model from the other systems in the class should create interest as to why (Forrester and Senge, 1980, pg. 220.) To implement the test, the general structure of the class of systems should be used. Then the parameter values should be set to correspond to the special model of interest. The model responses should be similar to the expected responses. This test helps ensure the model structure is correct and in line with accepted theory (Forrester and Senge, 1980, pg. 221.)

10. Surprise-behavior test: The surprise behavior test is similar to the behavior anomaly test. Here, however, the model has identified a behavior that is accurate but was unforeseen previously. The model may be discovering plausible scenarios that were not witnessed in the real world, therefore the surprise behavior under the modeled conditions was not apparent. A well represented model is more likely to discover such unexpected behavior, especially in the range of variable values that is not common yet not implausible in the real world (Forrester and Senge, 1980, pg. 221.) As in the behavior anomaly test, an understanding of the cause of the unexpected response When the unexpected behavior appears, the model builder must first understand causes of the unexpected response, then compare the response and its causes to those of the real system. The identification of surprise responses leads to further confidence in the accuracy of the model (Forrester and Senge, 1980, pg. 221.)

11. Extreme-policy test: To test the extreme policies of the model, the policy statements are altered in an extreme way and the model is run (Forrester and Senge, 1980, pg. 222.) The model should be able to handle extreme policy changes. This test differs from the extreme condition test in that policy statements include more than one variable. If the model handles extreme changes to the policies, greater confidence will be gained in the normal policy operating range (Forrester and Senge, 1980, pg. 222.)

12. Boundary adequacy (behavior) test: The behavioral boundary structure test is used in conjunction with the structural boundary adequacy test. It verifies that the addition or removal of structure does not affect the model's behavior (Forrester and Senge, 1980, pg. 222.) The test involves visualizing added structure and determining if the response is sufficient to warrant the additional structure (Forrester and Senge, 1980, pg. 222.) Again referring to the lunar cycle assumption, if the cycle is accurately represented, but the response of the system does not change significantly, then the added structure is not necessary. However, if the response of the system does change significantly, then the structure is useful and should remain in the model. Keep in mind that if the model structure is altered, then previous tests will need to be retaken. The purpose of the model must be kept in mind. If the extra structure provides a better response, but the response does not address the reason for the model, then the extra structure is not needed.

13. Behavior-sensitivity test: This test seeks plausible sets of parameter values that can cause the model to produce results inconsistent with the reference mode or expected results. If such values cannot be found, confidence is gained in the model structure (Forrester and Senge, 1980, pg. 222.) The test is usually executed by varying different variable values and analyzing the response. Keep in mind that tests resulting in failure may cause changes to parameter values, creating the need to repeat some previous tests (Forrester and Senge, 1980, pg. 223.)

Tests of policy implication: The ultimate objective of the system dynamics model is to test policies. The tests of policy implication differ from the other tests in that they specifically focus on policy changes and their responses (Forrester and Senge, 1980, pg. 224.) There are four tests discussed here, which include the system improvement test, the changed behavior prediction test, the boundary adequacy test, and the policy sensitivity test.

14. System-improvement test: This test is used to verify that policies found to produce favorable responses from the system in the model also produce favorable responses in the real world system. It entails physically implementing strategies tested in the model. The problem with the test is that strategies will not be implemented until complete confidence is gained, and if the test is implemented and favorable responses are gained, there is the possibility that factors other than the implemented strategy produced the favorable responses (Forrester and Senge, 1980, pg. 224.)

15. Changed-behavior prediction test: This test looks at the response of the system when changes to governing policy have been made. Either the policy in the model can be changed and results compared to previous policies and expected results, or the results can be compared to similar real world policies (Forrester and Senge, 1980, pg. 224-25.) Such a test allows greater confidence if expected results or results comparable to the real world ensue. This test is different from the behavior prediction test in that it focuses on policy changes rather than non-policy structure changes.

16. Boundary-adequacy (policy) test: This test checks to see how changes in model structure affect policy recommendations suggested by the model output. The test requires the modeler to conceptualize additional structure and analyze the response of the system when the additional structure is used (Forrester and Senge, 1980, pg. 225.) This test, like the boundary

adequacy (structure and behavior) tests, ensures the model is sufficient to meet the purpose of the model.

17. Policy-sensitivity test: Sensitivity testing of the parameter values can lead to insight into how these changes will affect policy decisions. The parameter values are altered, with the focus now being on the model response to policies as the parameters are altered (Forrester and Senge, 1980, pg. 225-26.)

Once an initial output that corresponds to the reference mode is obtained from the model, the previous mentioned tests will be employed to build confidence in the model. The results will be verified by the clients to ensure they meet with current intuition. At this point, modifications will be made as necessary, or the intuition of the client will be addressed, with the objective of eliminating any discrepancies between actual and expected results.

Implementation

The bulk of the thesis effort is directed at identifying and understanding the system in which solid waste generation can be reduced through an attitude/behavior cycle. However, the final step is to expand upon the understanding in hopes identifying means to alter current behaviors. Due to the subjectivity of the model employed, certain results can and can not be expected. For instance, we can alter the level of training and see if the response is favorable to our management objectives, but the results cannot be quantified to say that waste generation will change by a certain value. We can also alter different variables in hopes of identifying which should be altered to achieve the response most favorable to management objectives.

As a demonstration of the usefulness of the model, two specific scenarios will be conducted. Specifically, the training will be varied to represent real world possibilities. The external laws favorable to waste reduction waste will also be altered to represent a more realistic

community. Note that these two external influences affect the model in different areas. The response therefore should be different, whereas altering incentives will have results similar to altering the external laws to reducing waste.

Chapter 4
Analysis

Introduction

In order to successfully answer the thesis questions, a system dynamics approach is utilized. The main objective is to identify the attitude-behavior system that dictates solid waste generation and disposal, and explore the system to identify possible means of altering the attitudes and behaviors in a manner favorable to environmental protection and conservation. Chapter Three theoretically discusses the concept of a system dynamics approach. Now that discussion will be applied to this specific thesis effort. This chapter will discuss the conceptualization of the thesis, including the background of the problem, the reference mode, and influence diagram, the model formulation, the model testing, and the implementation of the model.

Conceptualization

The initial step is the identification of a problem. In this case, the problem of solid waste is apparent, as discussed in Chapter One. Given the problem of excessive generation of waste, the next step is to become familiar with the process of how and why solid waste is generated. The best means of doing this is to conduct an extensive literature search or to interview experts in the field. The clients, in this case the thesis committee, provided invaluable insight in the form of feedback into both the identification of the problem and the structure of the system of the problem. The information gathered about the problem suggested that one solution may be to study the problem from a system dynamics perspective because of the dynamic interactions of the attitude-behavior process.

Chapter Two provided information discussing the dynamic nature of the system, as well as references to authors suggesting a system dynamic approach as a possible means of exploring

solutions. From this background, the system dynamics approach to thinking was used to address the problem, with the focus on exploring a possible system of feedback incorporated into attitude-behavior theory. If this theory could be analyzed in a dynamic setting, then better insight could be gained, leading to more successful model representations in the future.

With an understanding of the system, a statement of the problem can be made, as well as specific questions to address. Chapter One lists both the problem statement and the research questions. However, before the main components of the system or the structure of the model can be identified, the reference mode must be developed to guide the direction of the solution and the formulation of the model. Richard Bagozzi states that in most models, action is initiated with a processing of information. Next there is an evaluation of the information and a development of an attitude. Finally, there is the intention to act prior to performance of a particular behavior (Bagozzi, 1982, pg. 562.) The processing of information includes the information gained as a result of the action or behavior, hence the feedback loop. This description, in line with Fishbein and Ajzen, is the basis of the reference mode.

The guiding reference mode for this effort is the theory of reasoned action (TRA) applied to the problem of solid waste, with a mechanism for feedback to connect behaviors to beliefs. Human behavior can be explained in terms of an assumption that an individual is fully functioning and capable of processing available information, which mediates effects from biological and environmental factors (Laudenslager, 1996, pg. H-4.) The TRA follows this assumption. It holds that people are usually quite rational and make systematic use of the information available to them, rather than being controlled by unconscious motives or desires. People engage in behaviors only after considering the implications of their actions (Laudenslager, 1996, pg. 2-30.) It is a special case of the theory of planned behavior in which people are assumed to have a high degree

of volitional control over behaviors (Laudenslager, 1996, pg. 2-45.) The TRA is a causal representation of the determinants of behavior, with prediction and understanding being the ultimate goal (Laudenslager, 1996, pg. 2-30.) It is consistent with a system dynamics approach to investigating the attitude-behavior relationship.

The TRA indicates that as more beliefs in favor of reducing solid waste are gained, attitudes will become more in favor of reducing solid waste. As the attitudes become more friendly towards reducing solid waste, intentions about behaviors that are favorable to reducing solid waste will be gained. As these intentions are gained, the actual behaviors performed will be more favorable towards reducing solid waste. Once the behaviors become more focused on reducing solid waste, less waste will be generated. With less generation of waste, people will believe there is less of a waste problem, which will result in less favorable attitudes, intentions and behaviors. The resulting decrease in favorable behaviors will lead to more waste generation and beliefs more favorable to reducing solid waste. The pattern would continue until a steady state level was reached, where peoples' beliefs, attitudes, intentions, and behaviors about the level of waste corresponded to a steady waste generation level. Figure 4-1 illustrates a graphical representation of the reference mode.

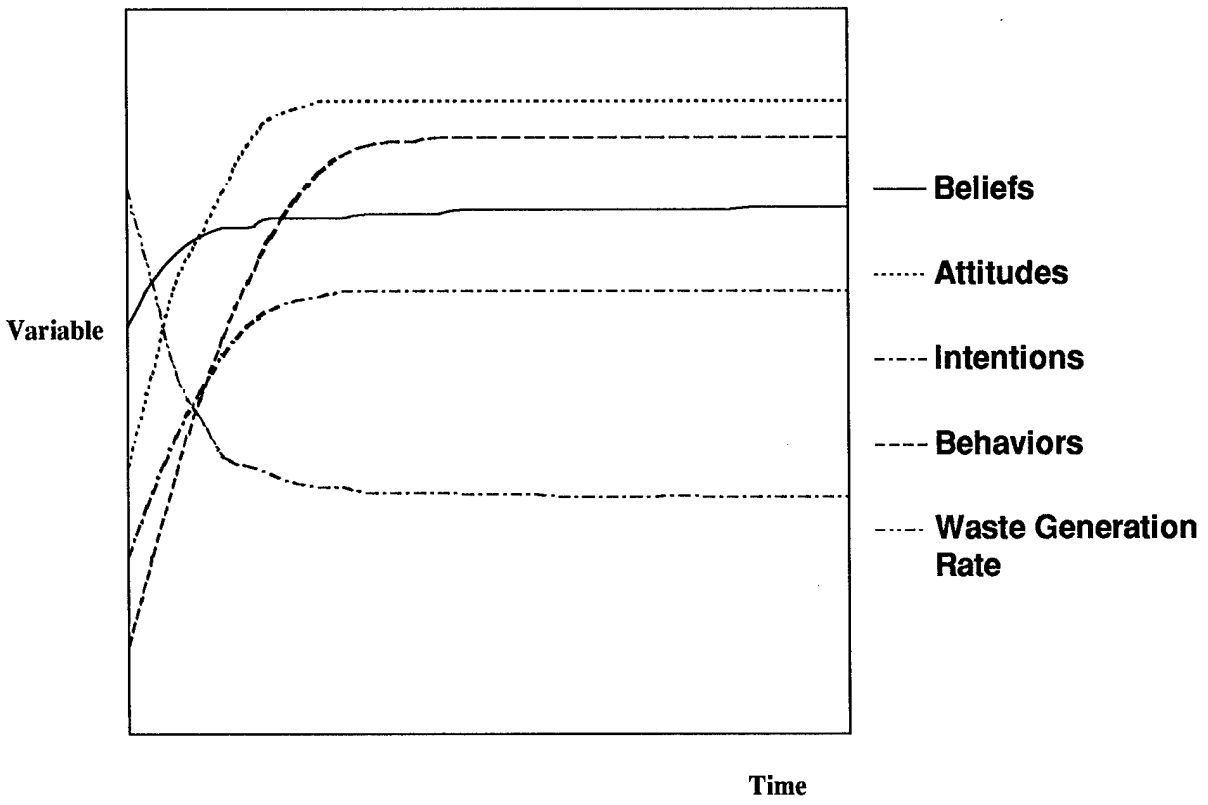


Figure 4-1 Reference Mode

Momentary changes to the external conditions should create a response in the system, but the system should return to its steady state level once the changes are removed. Only sustained changes will result in the steady state levels being permanently altered. Long term changes to perception due to media attention and other external factors, as discussed by Downs, are not included here because they are external to the immediate attitude behavior system and would only serve to complicate the model. The inclusion of such influences would be a good area for future research.

Given this reference mode to guide further efforts, the influence diagram was created. First, all components to the system were identified. Then, all influences between components were identified. The direction of the influence, as well as if the influence were positive or

negative, was next added to the diagram. The result was a first iteration of the influence diagram, which represents a system that would give the expected results of the reference mode. Figure 4-2 illustrates the diagram and represents how the actual action of waste generation will affect attitudes and behaviors. Further, it identifies external components which were initially thought to influence the system. As shown, increases in waste generated would create increases in attitudes favorable to reducing waste levels. Increases in attitudes would create increases in behaviors, which in turn would create decreases in the amount of waste generated. The system creates a negative loop that seeks to reach a balance between the waste generated and the attitude towards that waste level. The negative loop creates the goal seeking behavior identified in the reference mode.

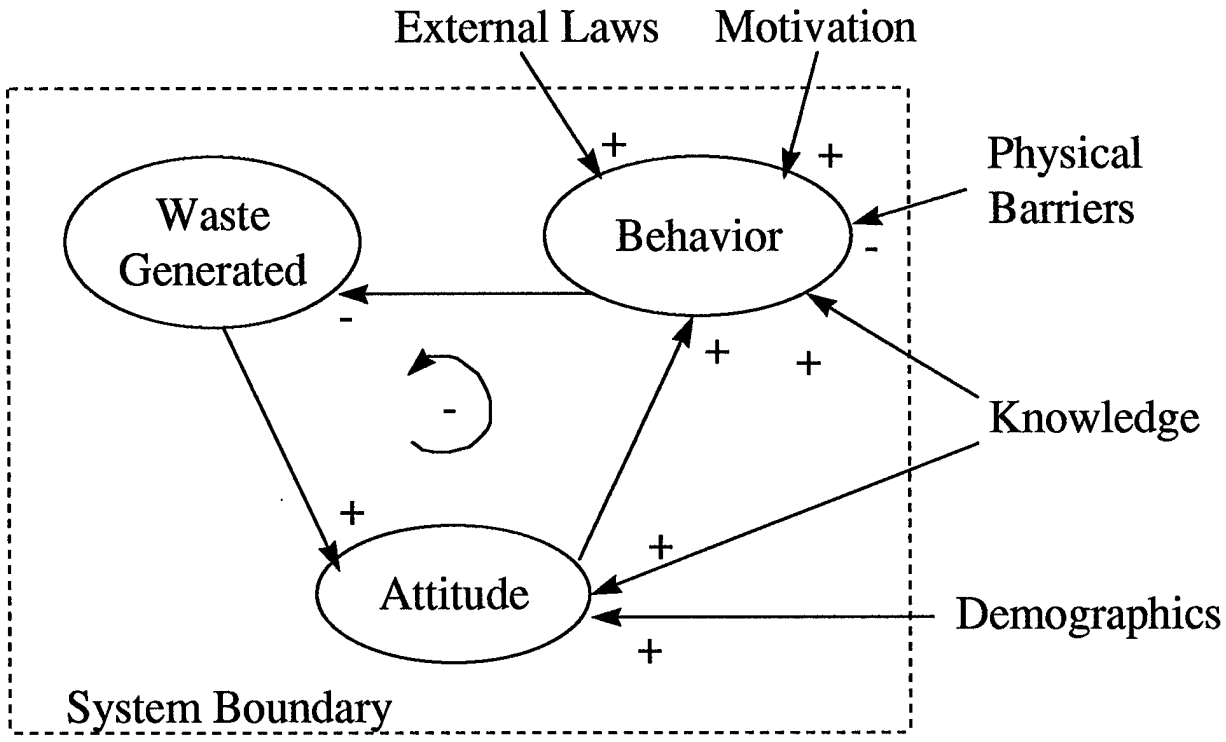


Figure 4-2 Initial Influence Diagram

As better insight into the system was gained through further literature review and initial attempts at model formulation, the influence diagram was iteratively refined. The final influence diagram is illustrated in Figure 4-3. It contains two negative loops working together to achieve the goal seeking behavior. The feedback is achieved through perception, both of waste as a problem in the normative loop and as the level of effort exerted towards reducing waste as compared to the cost of doing so in the behavioral loop. If the waste level is not seen as problem, the level of behavior towards reducing waste will decrease. Likewise, if the current level of waste is seen as excessive compared to the benefits received from reducing waste, then the behavior level will decrease. At this point, all variables to be included are identified, with any other variables either not identified or considered and disregarded. The model can now be constructed from this influence diagram to build a model that will represent the reference mode.

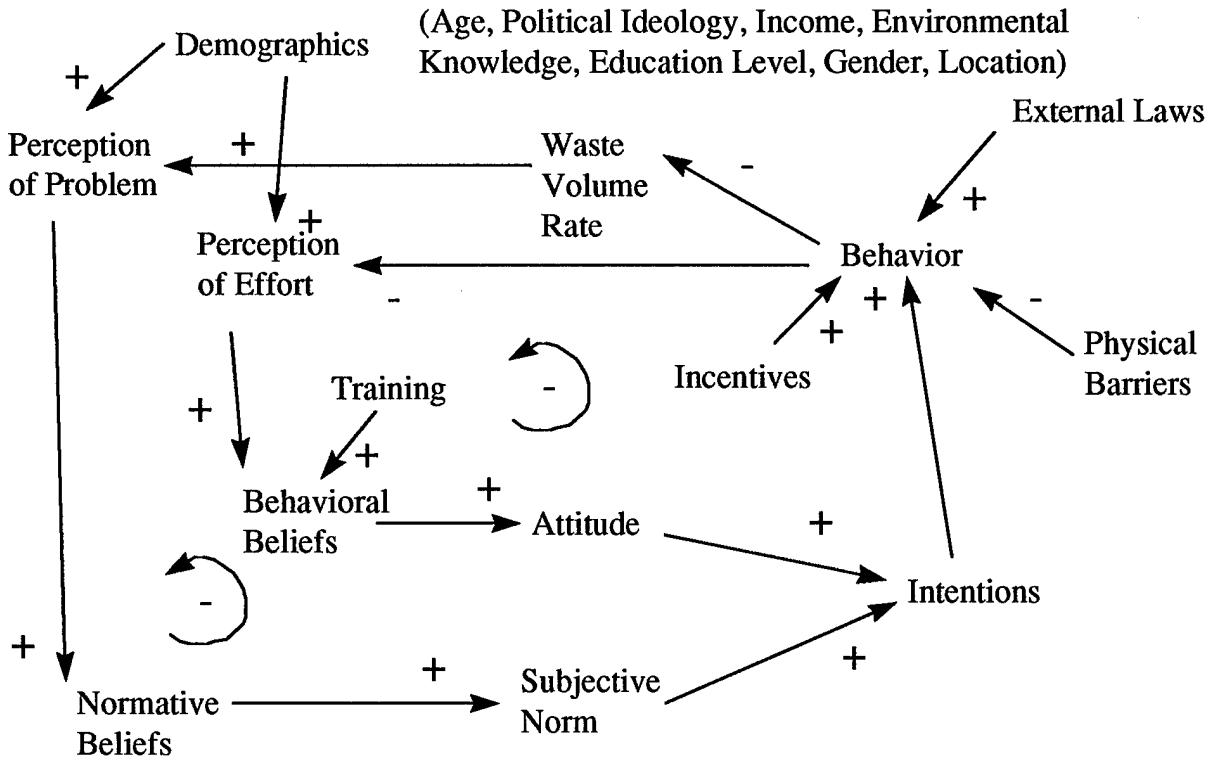


Figure 4-3 Final Influence Diagram

Model Formulation

With the influence diagram finalized, the next step is to build the mathematical model that will represent the real world system. Alwin suggests that the proper steps in 'building a model which represents the theoretical relationship between attitude constructs and behavior is to specify first the variables which, along with underlying variables, cause variation in behavior - and then to include these variables in models ... which make clear the theoretical assumptions about the ways in which the variables are related' (Alwin, 1973, pg. 276.) This is simply a reiteration of the system dynamics approach. To build the model, the system dynamics modeling software package STELLA II ® (version 3.0.7) was used. All of the variables were connected together into a model structure that STELLA II ® could use to create the mathematical formulas necessary to run simulations. The model itself is rather simple and will now be discussed in detail. Appendix A illustrates the actual model as it is represented in STELLA II ®, while Appendix B lists the values and/or equations used for each variable in the model.

The model is grouped into several areas. The main components of the TRA are represented as Behavioral Belief, Normative (or social) Belief, Attitude, Subjective Norm, Intention, and Behavior. Also grouped are the Solid Waste Level, Demographics, and External Influences. The components of each group and the assumptions made when quantifying them will be discussed in detail below.

It is important to realize at this point that trying to quantify the variables may be misleading. Nowhere in the original text of the TRA did Fishbein and Ajzen try to quantify any of the variables. By doing so now and connecting the variables together, we can get an indication of the magnitude of the responses as each entity interacts with the others. The scaling is rather arbitrary and actual numbers are in no way intended to represent real numbers. Varying the

numbers on a single scale allows us to visualize magnitude changes in the system and gain understanding of how important each component is relative to the others. Further, we can gain insight into how great a magnitude change of which components will give the greatest response in the favor of our desired outcomes. It is important to use an "expert opinion" when creating stocks from soft variables such as behavior. The nature of the flows that increase or decrease the "value" of behavior should be verified with experts or even clients. The same holds for assigning parameter values to many variables to produce behavior consistent with the reference mode or historical data. In the absence of either a client or a panel of referents with expertise in several areas of interest in the model, the committee assumed this role and acted to monitor the variable representations in the model.

The overall model is represented on a per person basis. The "person" is an individual person who represents the community average. The person is no one person in particular, but a cross section of the community as a whole. Unless noted otherwise, all variables in the model are arbitrarily scaled between negative one and one. This corresponds to a scale of zero to one hundred percent either for or against reducing solid waste. This allows negative values to actually decrease behavior, whereas positive values will increase behavior. Again, the values are used only to compare variables to each other and have no connection to the real world system.

There are two methods that can be used to define the relationships of several components that are aggregated into a single entity in the model. Bagozzi lists several authors who found that averaging the components into one component is better than summing the components when combining variables, although Fishbein and Ajzen preferred the adding method (Bagozzi, 1982, pg. 563.) However, there are problems associated with both methods. For instance the averaging method assumes independence of all the pieces of information used to form an overall prediction

method assumes independence of all the pieces of information used to form an overall prediction (Bagozzi, 1982, pg. 563.) This may or may not always be the case. This model uses the additive method when combining intentions with the external variables because the basis of the model comes from Fishbein and Ajzen's theory. Demographic variables are assumed to be independent and are averaged, as are attitudes and subject norms when forming intentions.

Demographics: Demographics will be discussed first because it is used to determine the beliefs of the average community. The model uses seven socio-demographic variables to determine a profile for the community that represents how favorable the community is to reducing solid waste. Each variable is given a value that corresponds to the community in question. Then each value is converted to a negative one-to-one scale. For age and income, each variable is normalized to the negative one-to-one scaling value from its input value. The other demographics are already entered on a scale from negative one-to-one. All seven are then weighted equally to determine the overall profile. Figure 4-4 illustrates the model configuration of the demographics section.

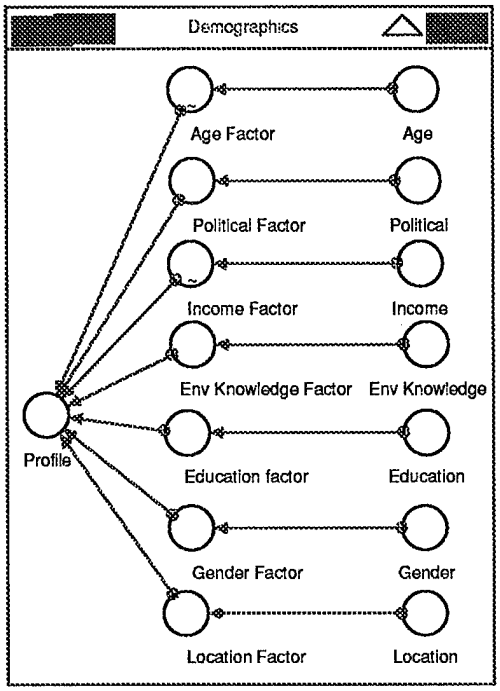


Figure 4-4 Demographics Model Representation

Based on the literature review, several researchers have attempted to identify which variables are stronger predictors of belief. Since there is little agreement on which are the most influential, and since their relative weighting continue to be analyzed and debated as far as their individual value in determining a person's favorability to reduce solid waste, they are all represented as being equally weighted. There has been no indication that any one variable is a better predictor than another. An excellent research opportunity would be to investigate the relative weightings of these variables

Age: Abbott and Harris found that there was a difference in views between people over 40 years of age and people under 40 (Abbott and Harris, 1985-86, pg. 226.) Therefore, the age value can vary between 20 and 60, with 20 year olds being highly in favor of reducing solid waste, 40 year olds being neutral in their views, and 60 year olds being highly against reducing solid waste. The age factor is normalized by assuming it is inversely linearly proportional to the

age value, with 20 corresponding to 1 and 60 corresponding to -1. The age values represent the average age extremes for a given community. In the event that the mean community age is lower or higher than the extremes, the age factor will default back to the 1 or -1 values. I assume that a community with a mean age higher than 60 will have different views about waste different from a community with a mean age of fifty. A similar assumption is made for mean ages lower than 20. The initial value is set at 30, indicating a younger age group.

Political Ideology: Political views can range from purely Liberal (represented by a 1) to purely Conservative (represented by a -1.) As suggested by Van Liere and Dunlap, those people with dominant liberal views are in favor of reducing solid waste while those people with dominant conservative views are against reducing waste (Van Liere and Dunlap, 1980, pg. 192.) People with conservative views generally have stronger concerns, such as business interests, that outweigh environmental concerns. The political factor is equal to the political value. The initial value is set at .7, indicating a community that is more liberal in its views.

Income: Annual income can vary from $12,000 to $36,000 with $12,000 being against reducing solid waste and $36,000 being for reducing solid waste. The value ranges are approximated from the average incomes of the most and least environmentally friendly groups, as discussed by the Roper Organization (The Roper Organization, 1990, pg. 50.) were approximated to be at the low and high ends of the national average income levels. The 95th percentile values of the community in question would be best used here. The income factor is normalized by assuming it is linearly proportional to the income value. The income factor corresponds to -1 at very low levels of income, increasing linearly to 1 at high levels of income. The initial value is set at $30,000, indicating a rather wealthy neighborhood.

Environmental Knowledge: Environmental knowledge can vary from -1 to 1. As suggested by Arcury, it is assumed that increased knowledge leads to more environmentally favorable attitudes (Arcury, 1990, pg. 300.) Therefore, low environmental knowledge is represented as a value of -1 and high environmental knowledge is represented by a value of 1. The environmental knowledge factor is equal to the environmental knowledge value. The initial value is set at .5, indicating a higher than usual knowledge about the environment.

Education Level: The Roper Organization found that education is related to environmentalism, with people with higher education levels more likely to be involved (The Roper Organization, 1990, pg. 53.) Therefore, the education value can vary from -1 to 1. A high school education is represented by a value of -1, an undergraduate degree is represented by a value of 0, and a post graduate degree is represented by a value of 1. The education factor is equal to the education value. The initial value is set at .7, indicating that the community as a whole has better than an undergraduate level degree.

Gender: The Roper Organization also found that women are more environmentally friendly than men (The Roper Organization, 1990, pg. 56.) Therefore, the gender value can vary from -1 (all masculine) to 1 (all feminine). However, Abbott and Harris suggest that the attitudes correspond to the roles men and women play in society, rather than their actual gender (Abbott and Harris, 1985-86, pg. 226.) The gender value is then a reflection of people's beliefs based on gender roles. Men can have feministic beliefs and women can have masculinistic beliefs. The gender level of a community is more complicated than counting the number of each in community, but involves understanding each person's role in the community. The gender factor is equal to the gender value. The initial value is set at 0, indicating the community is neither feminine or masculine in its beliefs.

Location: Van Liere and Dunlap found that environmental concern is related to an urban or rural residence, with urban residents being more concerned than rural residents (Van Liere and Dunlap, 1980, pg. 191.) Therefore , the location value can vary from -1 (rural) to 1 (urban). The location factor is equal to the location value. The initial value is set at .85, indicating a highly urban neighborhood.

The profile value is comprised of the seven demographic variables averaged together, each weighted equally. The profile combines all the demographic factors to determine the social beliefs of the community which determine the waste generation rate and level of waste reduction effort that are expected by the community. The initial profile indicates a community that is young, well educated and well environmentally informed, gender neutral, wealthy, urban, and politically liberal, which, according to the literature, represents a community that should desire to reduce its solid waste volume rate to a value below the national average. If the external factors do not prevent this behavior, we should see the behavior levels increase above the assumed average behavior level, resulting in a volume rate that decreases to a lower steady state level.

Behavioral Belief: The behavioral beliefs are a result of the perception of level of effort being exerted to reduce waste. This perception is modified by the level of training received, as illustrated in Figure 4-5. The two variables are additive. Training will be discussed in the external variables section.

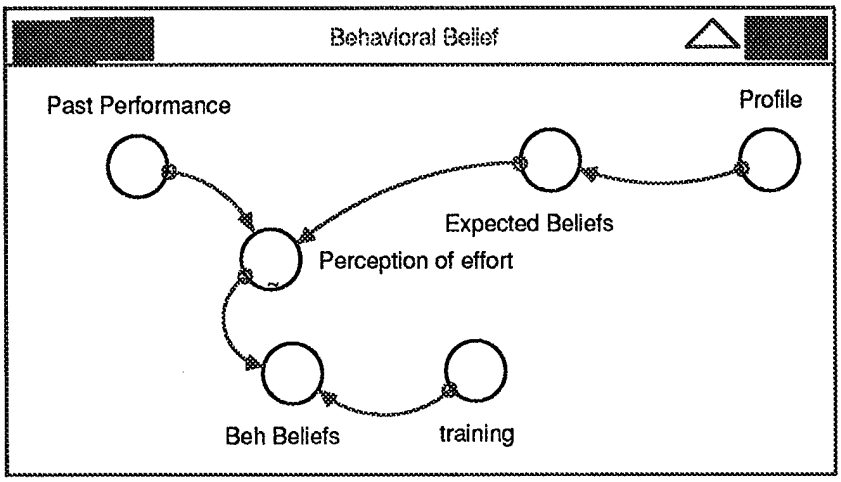


Figure 4-5 Behavioral Beliefs

Perception of effort compares past level of behavior with the expected behavior level. The expected beliefs are determined by the profile of the community. The community profile is translated into beliefs that an individual has about the "correct" level of behavior for reducing waste. The past performance is a reflection of the previous behavior level.

The perception of effort is obtained by subtracting the expected beliefs from the past performance. The difference is non-linearly inversely related to the perception of effort. If past behavior is higher (positive values) than the expected level of effort as determined by the community profile, then perception of effort will be negative, implying that more effort is currently being done than is needed. If past behavior is lower (negative values) than the expected behavior level, then perception will be positive, implying less effort is currently being performed than is expected by the community. The perception of effort reflects a community's desire to weigh their actual efforts against the benefits of those efforts. The non-linearity exhibits the assumption that the perception of effort will change more drastically at extreme values of differences between past behavior and expected behavior rather than at moderate values,

illustrated by Figure 4-6. The actual shape of the non-linearity is subjectively determined, however, minor variances in its shape did not alter the behavior enough to warrant investigation of the actual shapes. Further studies can investigate the relationships between the parameters. Past behavior can range from zero to any positive number, while expected beliefs varies from negative one to one. The difference between the two can take any value greater than negative one (lowest past behavior value minus greatest expected beliefs value) but the system defines any value higher than three as having no different effect than a difference value equal to three. The past behavior will be greater than the expected beliefs to the extent that perception of not enough effort being performed as expected by the community is at its maximum.

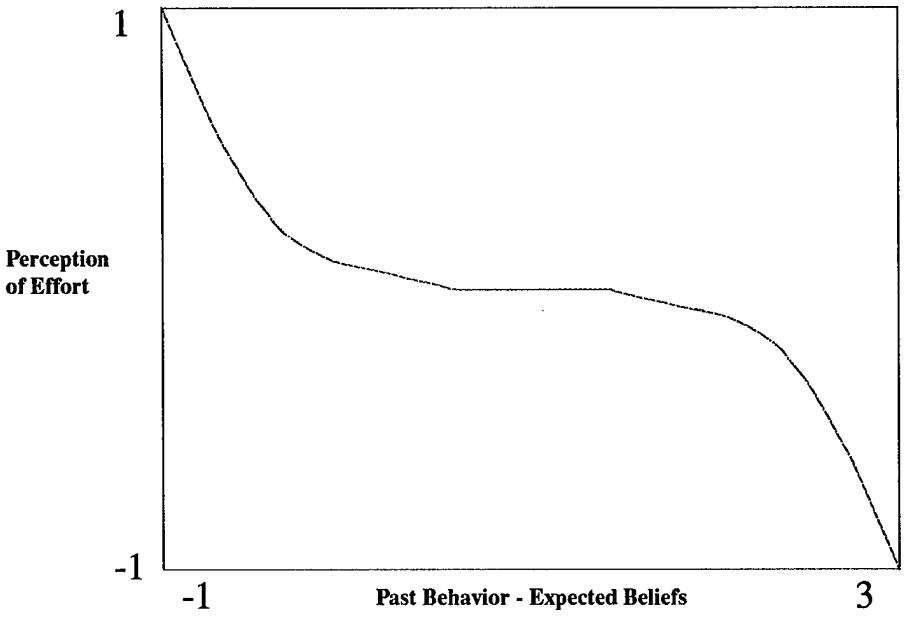


Figure 4-6 Perception of Effort

Normative Belief: The normative beliefs are a reflection of the perception of a problem with solid waste. As Lutz points out, they are "the individual's perception of the expectations of the referents with respect to the behavior" (Lutz, 1977, pg. 197.) The community profile is

translated into a volume rate that an individual would assume is the "correct" waste level, as indicated in Figure 4-7.

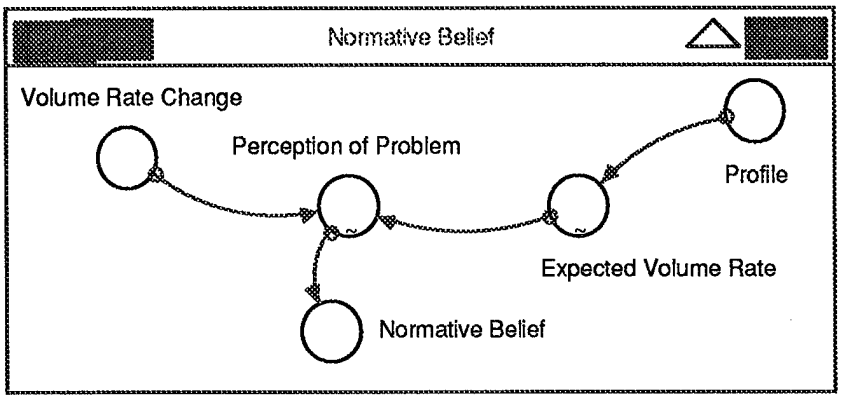


Figure 4-7 Normative Beliefs

The expected volume rate is centered around a scale from negative one to one, implying changes of waste generation from negative 100% to positive 100%, or complete reduction of waste generation to double the current waste generation. A community profile in favor of reducing solid waste (value greater than zero) will give an expected volume rate lower than the national average (less than zero), while a community profile against reducing solid waste (value less than zero) will give an expected volume rate higher than the national average (greater than zero.) The expected volume rate is then subtracted from the actual volume rate based on current behaviors. The difference is non-linearly proportional to the perception of a problem with the existing solid waste volume rate. The non-linearity exhibits the assumption that the perception of a problem with waste will change more drastically at extreme values of differences between the volume rate change and the expected volume rate rather than at moderate values, as illustrated in Figure 4-7. The actual shape of the non-linearity is subjectively determined, and further studies can investigate the actual relationships between the parameters. The volume rate change and the

expected volume rate can each range from negative one to one. The difference between the two can then vary from negative two (lowest volume rate change value minus greatest expected volume rate value) to two (greatest volume rate change value minus lowest expected volume rate value.)

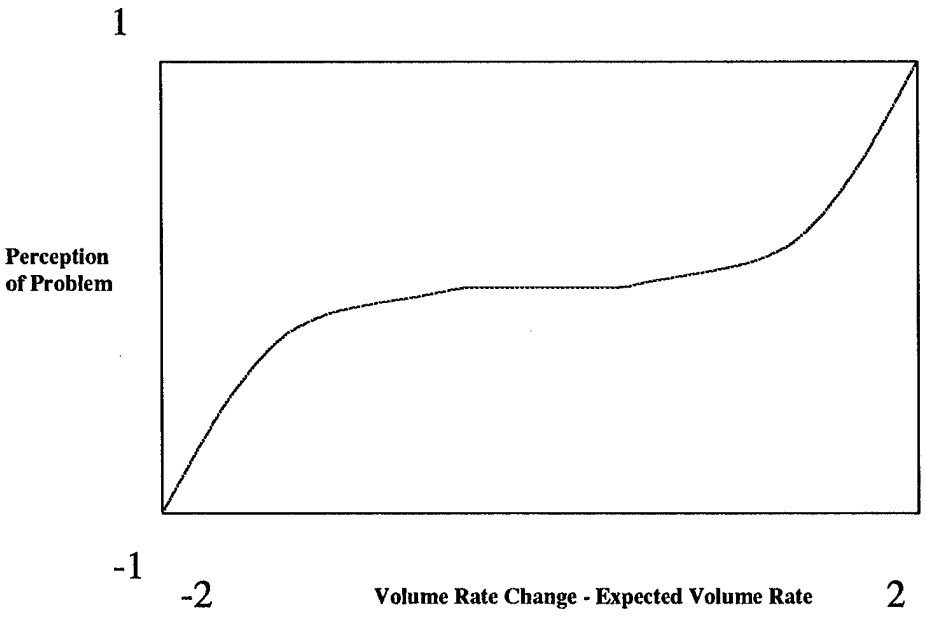


Figure 4-7 Perception of Problem

Attitude: The attitude toward the behavior (A_B) is the sum of the behavioral beliefs (b_i) multiplied by the attribute evaluations (e_i) (Fishbein and Ajzen, 1975, pg. 301), as indicated in the following equation:

$$A_B = \Sigma (b_i \times e_i)$$

Here the attribute evaluation, which is the individual's evaluation of the consequences, is set to one because the literature does not support, nor does it address, a decrease in attitude based on the attribute evaluation. In other words, the behavioral beliefs predict the attitudes, and there is currently no indication that the attribute evaluation detracts from that prediction.

Subjective Norm: The subjective norm (SN) is the sum of the normative beliefs (nb_i) multiplied by the motivation to comply (m_i) (Fishbein and Ajzen, 1975, pg. 301), as indicated in the following equation:

$$SN = \sum (nb_i \times m_i)$$

Here the motivation to comply is set to one because the literature does address it. Lutz found that results obtained without the motivation to comply were at least as good as those found with it (Lutz, 1977, pg. 197.) Since the motivation to comply did not alter the prediction of the subjective norm, the motivation is set to one.

Intention: As indicated by Fishbein and Ajzen, the intention to perform a given behavior (BI) is the attitude (A_B) summed with the subjective norm (SN), each weighted accordingly (Fishbein and Ajzen, 1975, pg. 301), as indicated in the following equation:

$$BI = A_B \times w1 + SN \times W2$$

The weights are set to .5, which indicates that in this model the attitude and subjective norm are weighted equally. To get better values for the weights, Lutz claims that empirical results would be required (Lutz, 1977, pg. 197.)

Behavior: The behavior is a stock value in this model. This means that behavior can accumulate. As long as people intend to behave favorably, the behavior level can increase, representing ever increasing efforts to reduce solid waste. The behavior change, which alters the level of behavior, is a summation of the behavioral intention, incentives, external laws, and barriers to the intention (the last three of which will be discussed in the external variables section), and is illustrated in Figure 4-9. Change in Behavior is defined as Intention + Incentives + External Laws - Barriers to Behavior. This is in line with Leonard Gordon's review of Robert Kahn's

study dealing with the impact of anti-Semitic attitudes upon exclusion of Jews from executive positions, where the intervening variable effects were found to be "largely additive" (Gordon, 1969, pg. 250), which means the effects were independent of each other. The initial value is completely arbitrary and is set at .6.

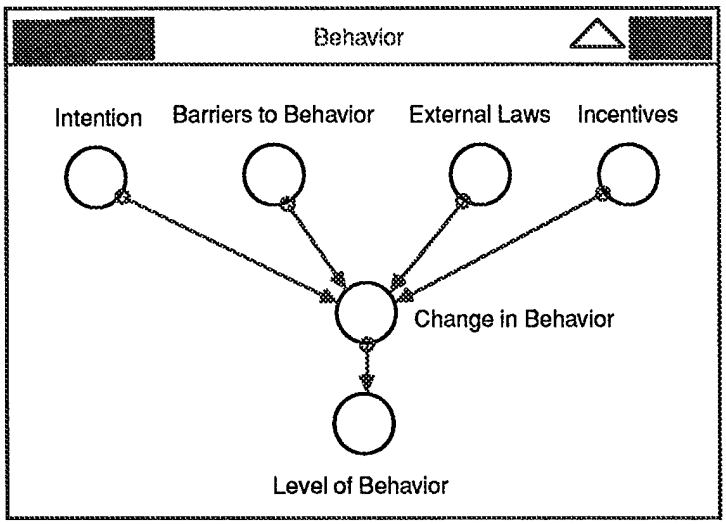


Figure 4-9 Behavior

For the system to reach steady state, the behavioral change must approach zero, creating a constant value in the behavior stock. That value should dictate the community's current effort level to reduce solid waste, based on the assumed external variable values. Since the model values are subjective, any single run of the model will not give useful information. In comparing the steady state values when different variables are changed, however, we can gain insight into the usefulness of pursuing those changes.

Solid Waste Level: The solid waste level illustrates the volume of solid waste generated at a given time. The volume rate change is non-linearly inversely proportional to the behavior level. As the level of effort to reduce solid waste increases, the volume rate of solid waste will decrease. Assuming a behavior of 1.5 gives a typical per capita disposal rate, a behavior of 0 will give a

disposal rate of one, which is 100% higher than the average, or double the average. A behavior of +3 will give a disposal rate of negative one, or one hundred percent lower than average. Note the extreme of negative one implies no waste is being generated. The non-linearity exhibits the assumption that the volume rate change will change more drastically at extreme values of behavior rather than at moderate values as illustrated by Figure 4-10. The actual shape of the non-linearity is subjectively determined, and further studies can investigate the actual relationships between the parameters.

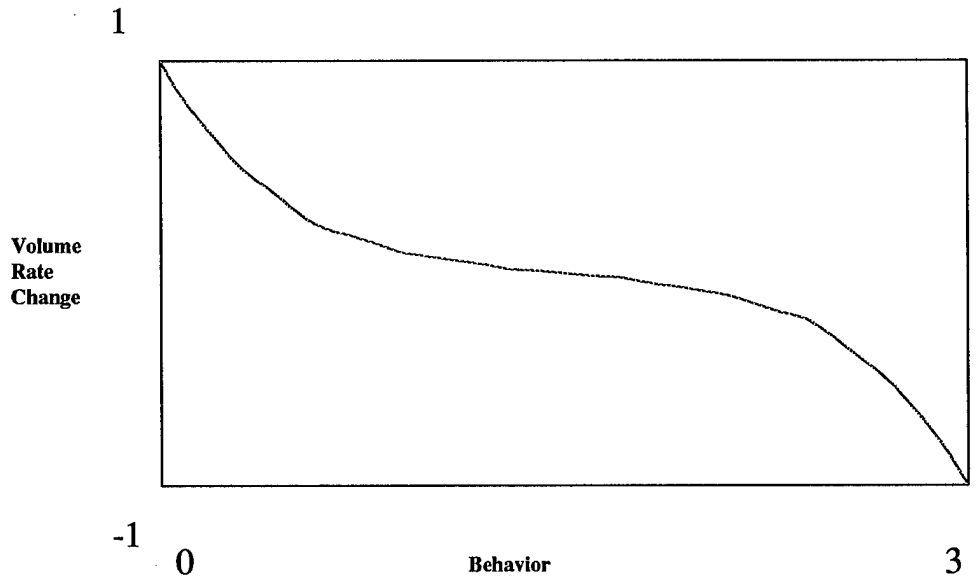


Figure 4-10 Volume Rate Change

External Influences: This model uses three external influences to limit behavioral intentions (see Figure 4-9) and one to modify behavioral beliefs (see Figure 4-5), as discussed in Chapter Two.

Barriers to Behavior: Barriers to behavior represent any action or entity that "impedes behaviors derived from intentions" (Fishbein and Ajzen, 1975, pg. 298.) Such barriers may include the absence of a collection system for recyclable materials in a community, such as a

curbside collection program or centralized collection bins. Without a means to recycle, waste reduction will be inhibited regardless of intentions. The barriers to behavior component is quantified from zero to one, with one being all barriers available in place. This does not imply that all behaviors are being prevented. Barriers to behavior are subtracted from the intentions, therefore negative values do not make sense here. A large value of barriers to behavior (one) represents the maximum possible barriers in place while a low value (zero) represents no barriers to the intention. An initial value of zero is used to indicate a system that has no barriers in place to prevent the reduction of solid waste.

External Laws: External laws represent any external pressure that causes a community to act in a manner inconsistent with its intentions. Although this may also be considered a barrier to behavior, laws are a special case that deserve separate inclusion, as discussed in Chapter Two. Laws include mandated recycling programs or waste reduction compliance goals. Although rare, some laws may inadvertently increase landfilling because of compliance with other statutes, such as a ban on the reuse of food containers. If a community that reused containers is prohibited from continuing to do so, but no recycling program is in place for the containers, then the usual alternative is to landfill the containers and buy new ones. Here the value for external laws can vary from negative one to one, where negative one indicates the presence laws that actually prohibit solid waste reduction (mandate solid waste generation) and one indicates the presence of laws that require solid waste reduction. A value of zero indicates the absence of laws either for or against recycling. An initial value of zero is used to indicate a system that has no laws in place to prevent the reduction of solid waste. This could also indicate the presence of laws that have the net effect of canceling each other out.

Incentives: Incentives represent any attempt to persuade people to perform a behavior that does not agree with their intentions. Incentives can be thought of as the inverse of barriers but again deserve unique consideration. Incentives to reduce waste include monetary compensation for diverting waste, while disincentives may include monetary gains from not recycling. Often it is cheaper to landfill trash rather than recycle it. Sometimes trying to begin a waste reduction program can be complicated, and simply landfilling the trash is easier and less time and labor intensive. Incentives can be valued from negative one to one, with one being incentives to reduce solid waste as much as possible and negative values corresponding to incentives not to reduce solid waste. An initial value of zero is used, which indicates a system that has no incentives in place to encourage or discourage the reduction of solid waste. This could also indicate a system where the incentives equal the disincentives, thereby canceling each other out.

Training: Training acts to alter behavioral beliefs in favor of reducing solid waste. Training is often used to reduce solid waste, such as programs on what materials to recycle and when in a particular community. However, training can occasionally act to prohibit recycling, such as training in efficiency in a particular community that suggests recycling is not efficient or cost effective because the material must be handled more often and high fees are required for disposal. Training that stresses health factors above recycling, such as glass containers being dangerous if broken, can exist, but often are short term problems as new equipment and procedures for handling the recyclable material are put into place. Training can have a value from negative one to one, with one being all of the pro-recycling training required to fully complement one's beliefs and negative values representing training against recycling. An initial value of zero is used, indicating that there is currently no training taking place either for or against recycling.

Again, if the initial values of the external influences do not prohibit such behavior, we should see the behavior levels increase above the assumed average behavior level, resulting in a volume rate that decreases to a lower steady state level.

Testing

As discussed in the previous section, the initial output from the model should show a decrease in the volume rate. The initial output should exhibit results expected from the reference mode. The initial mental picture of the system was that of a goal seeking system, with the values of behavior, intention, attitudes, and beliefs approaching steady state over time. In addition, we should see the volume generation rate (Vol Rate Change) reach a steady state value. Figure 4-11 demonstrates this expected behavior.

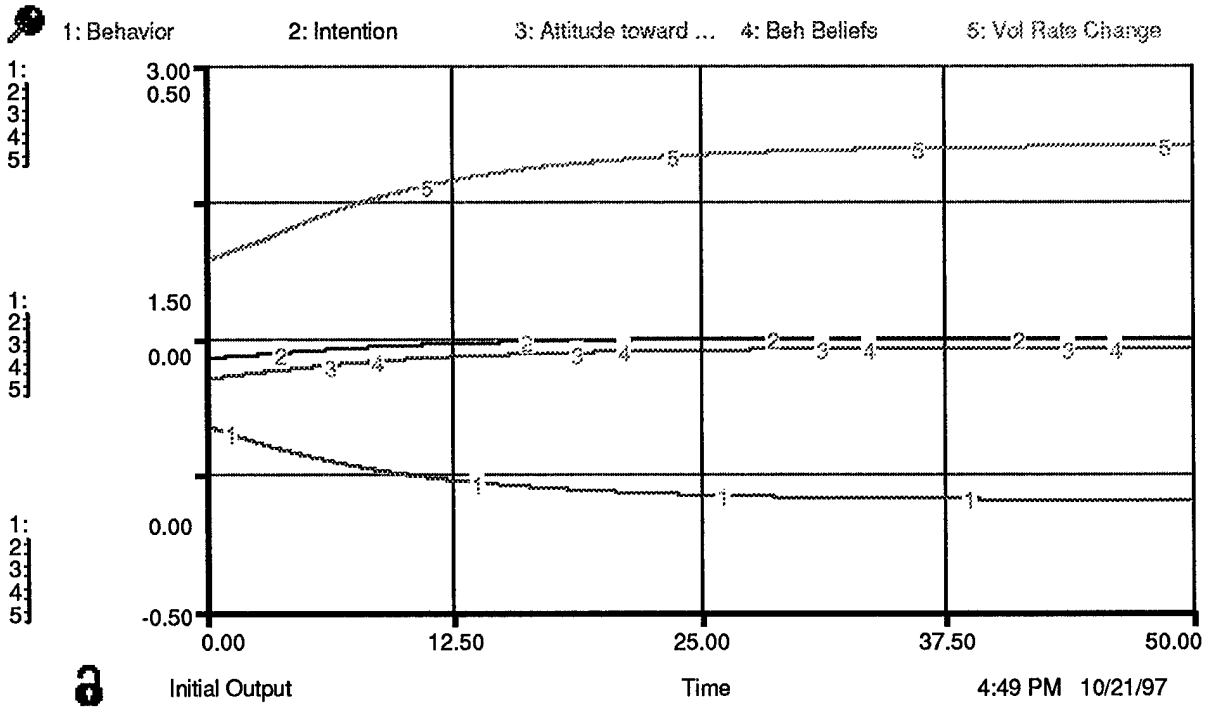


Figure 4-11 Initial Output

As we can see, the expected goal seeking behavior is obtained. Matching the reference mode gives confidence that the model structure is correct, which is discussed further below.

Figure 4-11 illustrates the expected reference mode, but the actual magnitude of change cannot be determined at this point. As discussed in Chapter Five, the weights of the variables are assumed to be equal at this point. Also the subjectivity of the component values results in little useful information after one run of the model. However, as variables are changed and the model is run successively, changes in model response will give insight into how the variables interact with the system.

Chapter Three discussed several tests that help to validate the usefulness of a model. These tests will now be applied to this model, with the results being discussed. The testing will begin with the tests of the model structure, followed by tests of model behavior and tests of model policy, respectively.

Tests of the model structure:

1. Structure-verification test: In a model such as this, it is difficult to compare the model structure to the real world system because the actual system is unknown. However, the model is based on a popular attitude-behavior theory, as well as relevant literature. It also underwent the scrutiny of criticism through successive committee meetings. Therefore confidence is gained that the structure is acceptable. With confidence gained in the model structure, the next step is to verify the parameters.

2. Parameter-verification test: The parameter verification test is very difficult in this model because of the subjective nature of the variables. However, the relative scaling of the variables allows us to see the variable values change with respect to influences imposed on each other. Without a reason to the contrary, it is only logical to keep all the variables on a similar scale. The polarity of the values is understandable, with negative values detracting from favorable behaviors and positive values enhancing favorable behaviors. Again the variables are based on

well documented theory and underwent committee review. Therefore confidence is gained in the parameter values.

Although the range of values seems plausible, tests on the range of values of the variables shows that the system is sensitive to the ranges. The problem lies in the reality of the values when viewed against the other variables. For instance, it does not make sense to have both the incentives fully in place (set to one) and all possible barriers to behavior in place (set to one.) In a real world scenario, this may happen, but the community would be very confused as to which is the correct behavior. Later sensitivity tests will show the sensitivity of the value ranges of the external variables. The model does not show as much sensitivity to the demographic variables, however, because they tend to average each other out. They are also compared to the model behavior, rather than directly influencing it, which tends to dampen them out. Finally, the weights used in the model can take on different values, but the weights always sum to one, so their range is set. The demographic weights, which are currently equal, can be debated, but as discussed earlier, with no better information derived from the literature, equal weighting is very realistic. With confidence gained in the parameter values used, the model is now ready to undergo the other tests that will build confidence in its utility.

3. Extreme-conditions test: To test the extreme conditions of the model, two sensitivity tests will be used. First, the demographic values will be polarized to show profiles both completely in favor and against reducing solid waste. Then the weights attributed to the attitude and subjective norm will be polarized to see if there is a difference between all behavioral beliefs and all social beliefs.

Figure 4-12 illustrates the volume rates when all of the demographics are set to resemble a person whose beliefs are definitely for waste reduction and when all of the demographics are set

to resemble a person whose beliefs are purely against reducing solid waste. The first represents a community that is young, well educated and well environmentally informed, feminine, wealthy, urban, and politically liberal. The second represents a community that is older, less educated and not as well environmentally informed, masculine in its beliefs, poor, rural, and politically conservative. This test checks the response of the extreme condition of a community that is either purely in favor of reducing solid waste or purely against reducing solid waste.

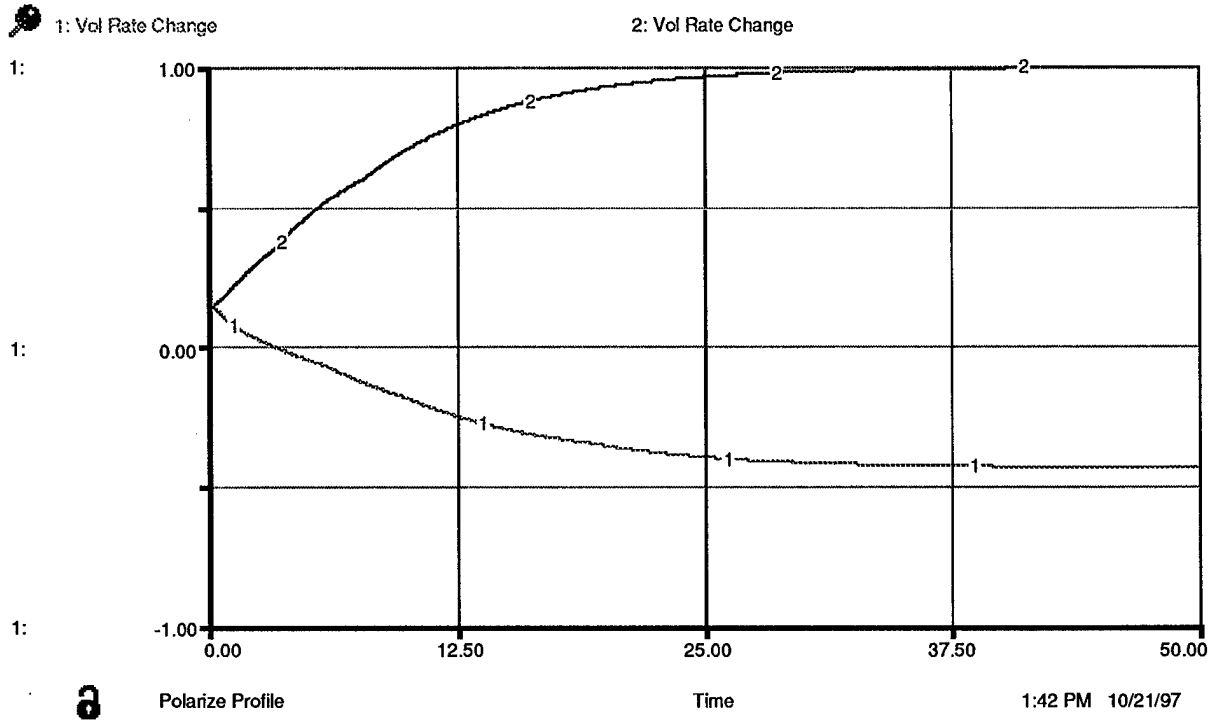


Figure 4-12 Pro- versus Anti-Waste Reduction Profile

As expected, a community with an extreme pro-waste reduction profile (line 1) will reduce waste much more than a community with an extreme anti-waste reduction profile (line 2.) Do to the choice of starting conditions, the pro-waste reduction community reaches a level lower than the starting value, and below the assumed value for average levels of behavior, corresponding to the zero line on the graph. The anti-waste reduction community views waste differently, resulting

in a higher level of waste generation. Note that if the starting conditions were different, the waste generation levels would still reach the same steady state waste generation levels.

The next test is whether or not there is significant difference between weighting the intentions completely towards the attitude towards the behavior or completely towards the subjective norm. Knowledge of such results may be important when deciding how best to encourage pro-waste reduction behaviors in a community as discussed by Borden (Gray, 1985, pg. 157-58.) Figure 4-13 shows the results of this test.

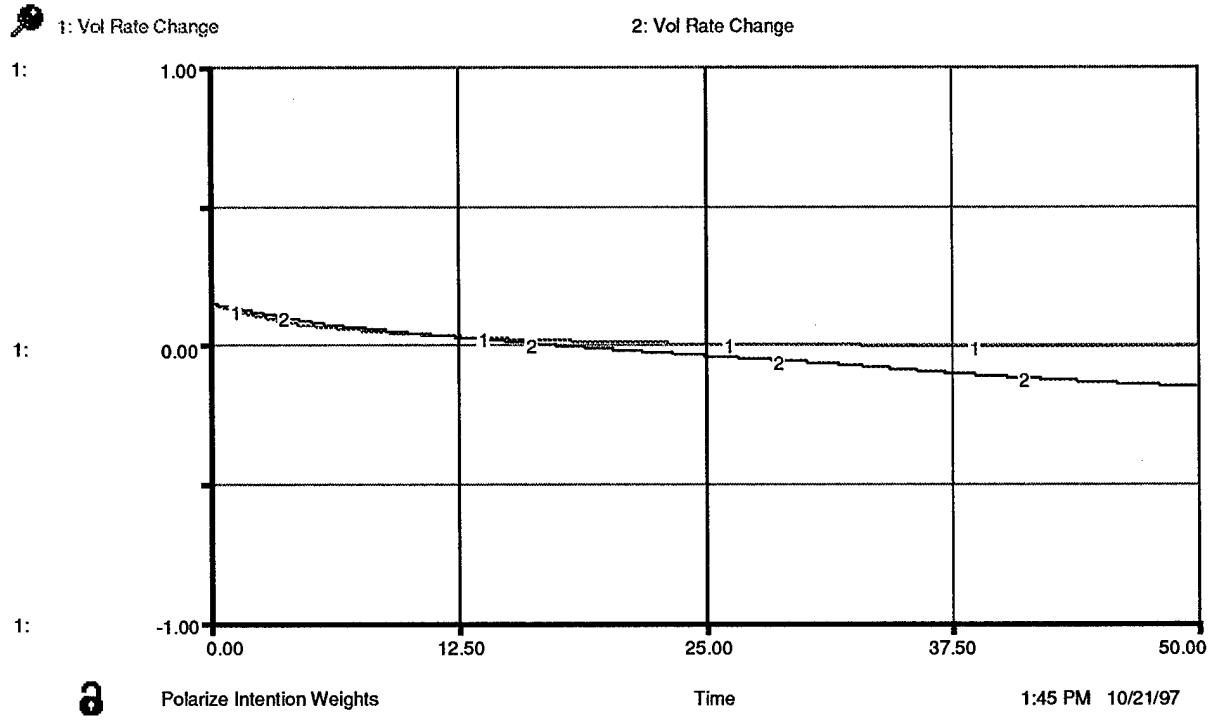


Figure 4-13 Behavioral vs. Social Dominance

The results here indicate that a community concerned completely with behavioral beliefs (line 1) will reduce waste slightly less than that community when beliefs are completely socially based (line 2), all other factors being equal. This result may imply that factors affecting behavioral beliefs, such as training in how to reduce waste, may be less beneficial than demographic or cultural variables, such as general level of education or location. Possible means of changing

values may include targeting social factors such as generating concern for the environment in a social environment, such as community or school general education programs.

4. Boundary adequacy (structure) test: The boundary in this model is determined by a theoretical model, which does not include the feedback loop. This model representation, however, is adequate in that it provides the response expected in the reference mode. A response not in agreement with the reference mode would suggest a flaw in the model structure or in the initial reference mode. In this case, the initial response and the reference mode agree, which indicates that either they both are correct or incorrect. Since both are based on a well established theory, we can conclude that they are correct for the purpose of investigating the system further.

The inclusion of the external and demographic variables may leave open the possibility for inadequate structure. Although detail is lacking on how exactly each interacts into the model (if in fact the interaction is more complicated), the response is in agreement with the literature. Therefore the structure is adequate on the level that is currently employed. Again, the structure adequacy must relate to the intended purpose, which is to analyze waste reduction in terms of the attitude/behavior relationship defined by the TRA and gain insight on the factors influencing this system. We are able to gain insight into the system defined by the TRA. Chapter Five discusses future efforts, which can include striving to better define the relationships in hopes of obtaining more insight into the processes, but the conclusions drawn from the results at this level are sufficient.

5. Dimensional-consistency test: This model does not use scaling factors other than the original assumption of a scale from negative one to one. Since the model is based on a subjective scale, this initial scaling is valid, as discussed above. The absence of other scales makes this test irrelevant.

Tests of model behavior:

6. Behavior-reproduction tests: As illustrated in the initial output seen above, the expected behavior as defined by the literature and verified by the committee is reproduced. In the absence of actual real world data, it is difficult to assess the behavior reproduction tests. The results obtained from the model does not discredit the usefulness of the model, therefore no responses to the tests are warranted.

a. Symptom-generation test: In looking at the initial output, certain circumstances are seen to result in certain responses. For instance, when the community profile was polarized to a pro- or anti- waste reduction stance, the waste volume rate decreased or increased accordingly. The expected behavior was recreated in the model, therefore the test gave a positive result. The generation of an expected response gave confidence to the validity of the model.

b. Frequency-generation test and relative phasing test: These tests do not apply to this model because there are no randomly generated variables, or different functions available to define one variable. Also, there is no real world data to compare against, therefore it is unknown whether or not the frequencies or phases are being reproduced. The test is better performed when comparing model results against real world data.

c. Multiple-mode test: Since there is no set of data that identifies what the real world system response should be, it is impossible to tell if the correct cycles are being reproduced. Therefore this test is not useful for this particular model. Again, this test is better performed when comparing model results against real world data.

d. Behavior-characteristics tests: Again, the absence of actual data makes this test difficult to complete. The reference mode gave no indication of a specific behavior characteristic that could be used to determine the result of this test. As previously noted, the reference mode

was reproduced, giving credence to the model. As indicated by the literature, any fluctuation that is not sustained will not cause the community behavior to remain changed. Once the pulse has ended, the system will return to its initial steady state. If the change is permanent, the system will achieve a new steady state response (Gray, 1985, pg. 187.) This behavior can be seen by pulsing the barrier to behavior in year twenty and permanently increasing it in year forty. This may correspond to a budget constraint that eliminated curbside recycling for one year and a closing of an incinerator due to health or safety concerns while assuming that the waste diverted to these activities is now sent to a landfill. Figure 4-14 illustrates the response.

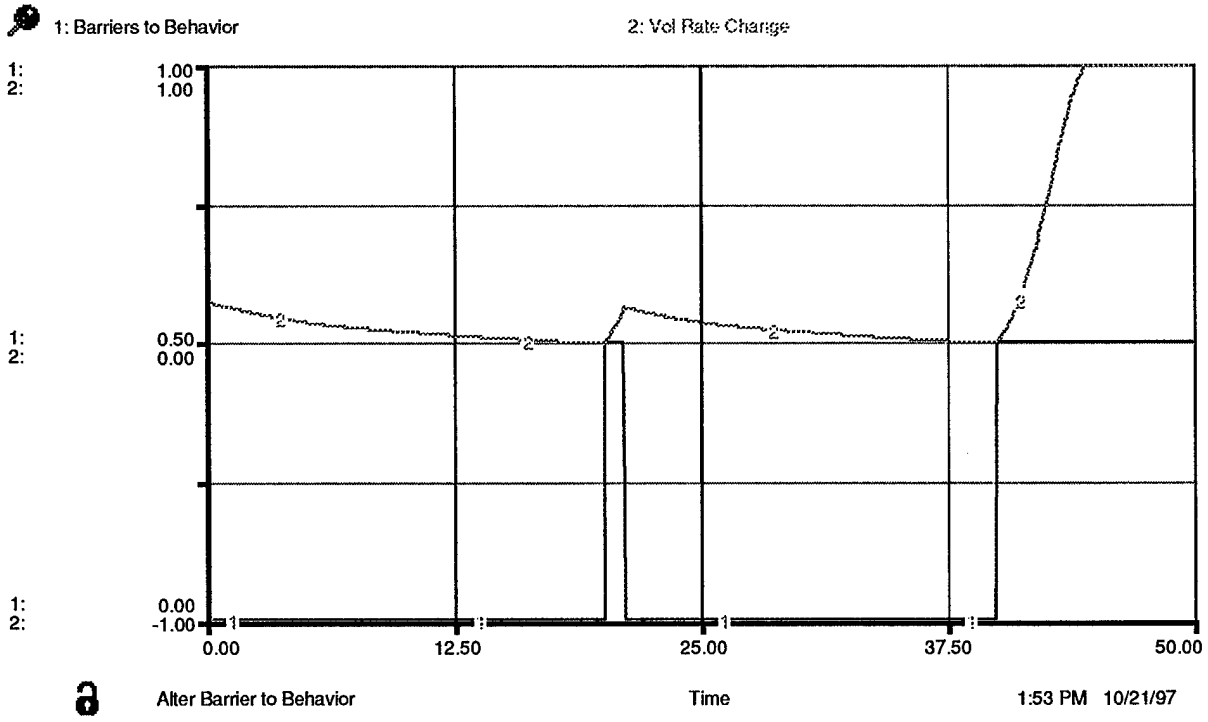


Figure 4-14 Alter Barrier to Behavior

As we can see here, the response is as indicated. The barriers to behavior increased at year twenty, resulting in an increase in the waste volume level. Once the barriers were removed at year twenty-one, the waste volume level returned to its initial steady state level. At year forty, the

permanent increase of barriers to behavior resulted in a new steady state level of waste generation, which reached the maximum value possible.

7. Behavior-prediction tests: Since the model is not based on actual data, there is no distinction here between events that have occurred and can be verified against the model results, and future events that cannot be verified. All model responses can be treated under the behavior reproduction tests. The pattern prediction test is simply a continuation of the behavior characteristic test, as is the event prediction test. The event prediction test can also be considered under the other behavior reproduction tests.

8. Behavior-anomaly test: This test is more prevalent in earlier iterations of model construction. No anomalies in the response exist in the final model, but earlier anomalies existed that helped to "de-bug" the model as it was constructed. One example was the tendency for the behavior to never reach steady state. After further analysis of the model, the behavior change level was reaching a steady state value other than zero, which allowed an unrestrained behavior increase corresponding to a decrease of waste volume. The test lead to the verification of the feedback mechanism of perception, which controls escalating behaviors in the goal-seeking system.

9. Family-member test: The model is based on the TRA which is an accepted member of the general class of attitude/behavior theories. Since no similar system dynamics models were known to be developed, the model cannot be compared to a class of systems.

10. Surprise-behavior test: As the behavior anomaly test was accomplished, all anomalies led to poor assumptions in the variable values or to inadequate or incorrect structure. No anomalies were found that were actually surprises to the responses of the system. This test simply did not come into play.

11. Extreme-policy test: One extreme policy test is to set the values of all of the external variables influencing behavior change to an extreme, such as unlimited support for or against reducing waste. Figure 4-15 illustrates the volume rate when the external variables are all polarized, first for and next against, at the same time.

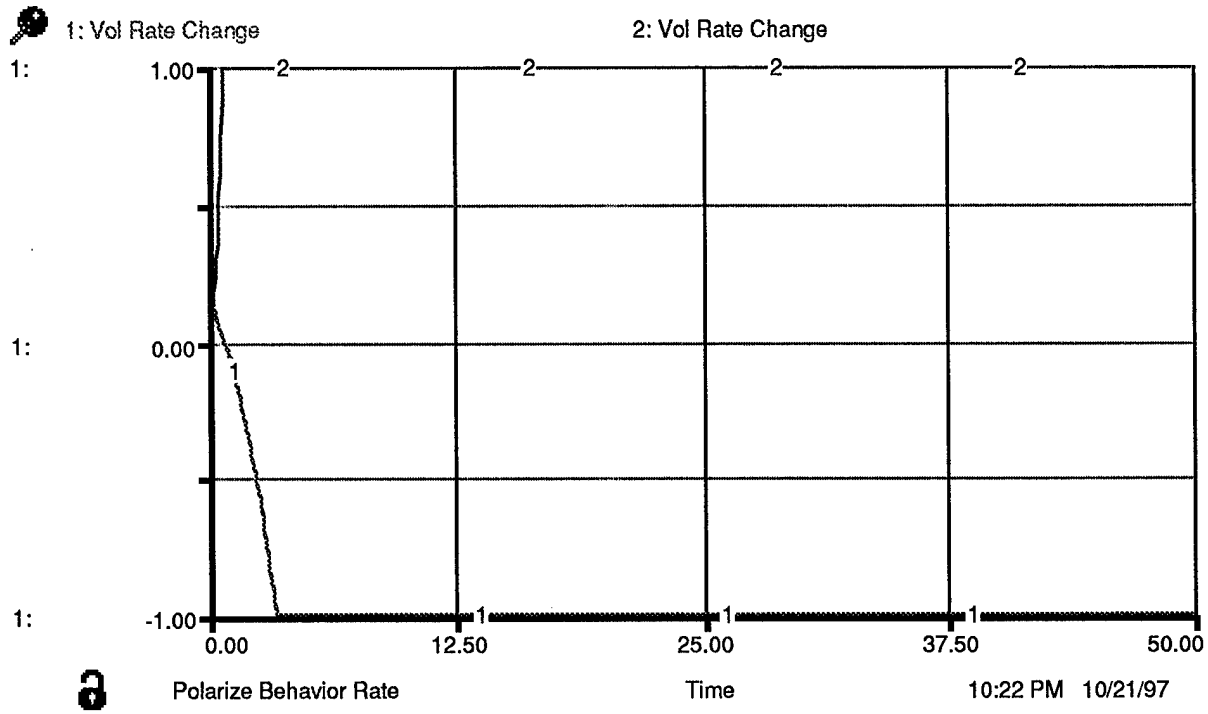


Figure 4-15 Pro- and Anti- Waste Reduction Behavior Rate Change

Here the first line corresponds to all barriers being removed, favorable laws being maximized, and favorable incentives being maximized. The second line corresponds to barriers at a maximum, unfavorable legislation being maximized, and unfavorable incentives being maximized. This does not correspond to the favorable conditions being minimized, which would correspond to values of zero as in the initial model run. Negative one corresponds to unfavorable conditions being maximized. Guagnano, Stern, and Deitz stated that as the external variables were increased, they would override the predictive ability of the attitude-behavior cycle and cause

the behavioral response to be determined by the external variables, which is seen above (Guagnano, Stern, and Deitz, 1995, pg. 704.)

The results of the extreme conditions tests show the response in the direction expected. However, complicating interactions, which are not apparent when defining the variables, may be adding to the sensitivity. An example may be values that do not correspond like barriers to behavior being fully in place while laws exist that encourage waste reduction. The sensitivity found may indicate that more structure may be needed to better define the relationship between the external variables themselves. Since the literature does not support a good understanding of the interactions here, the model is left simplified. The literature suggests that the variables interact with intentions independently (Gordon, 1969, pg. 250.) Other tests conducted suggest that the structure is satisfactory to produce plausible results.

12. Boundary adequacy (behavior) test: Previous iterations of the model included structure that was found to be complicating as far as understanding of the system. A structure representing local laws was added. The local laws were a reflection of the social beliefs and the level of local laws determined the level of barriers to behavior. The barriers to behavior in turn influenced the rate of behavior change. However, the social beliefs already influenced the rate of behavior change through the subjective norm and subsequently the intention, as seen in Figures 4-7 and 4-9. In this case the extra structure was merely complicating the model while giving exaggerated results. Other structure was added and deleted at various stages of model construction.

13. Behavior-sensitivity test: This model consists of many variables that have estimations of plausible values. Such variables are normally good candidates for the behavior sensitivity test, but in this case it would be extremely time consuming to test all variables and all combinations of

variables over all of their estimated ranges. Therefore we will focus specifically on the sections of the model that most concern us. We can assume that the components of the TRA are known and the values have not been assumed. This eliminates them from sensitivity testing. Another assumption we will make is that the weights of the demographic variables are known. This leaves the external variables and the profile to be tested for behavior sensitivity. The profile was tested earlier under the extreme conditions test, so this section will feature only the sensitivity tests of the four external variables.

Figure 4-16 is the first of the sensitivity tests on the range of values for the external variables. This test is for the barriers to behavior values.

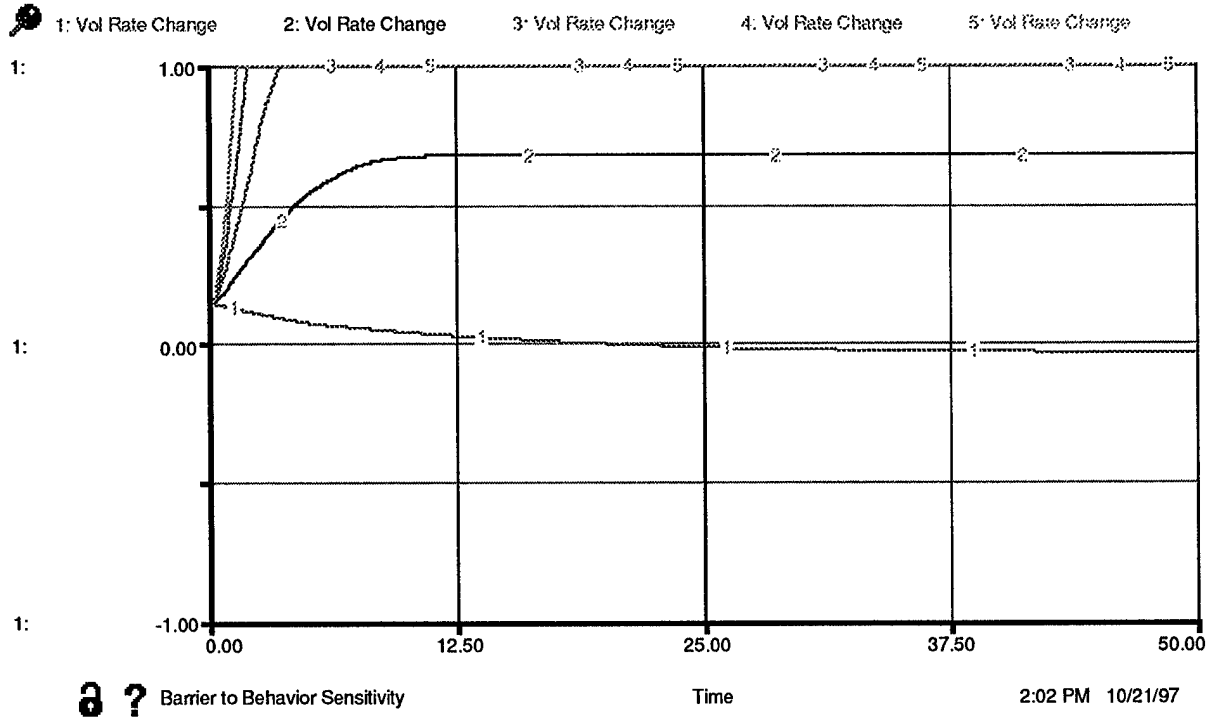


Figure 4-16 Sensitivity Test of Barriers to Behavior

The lines on the graph correspond to values of barriers to behavior starting at zero (bottom) and progressing towards one (top.) In this sensitivity test, we see that with extremely low values of barriers to behavior (the lowest two lines correspond to 0 and .2, respectively), the

community is able to reduce waste generation, while with the presence of any barriers at all, behavior is inhibited and waste levels increase drastically, limited here only by the assumption that waste generation can only increase one hundred percent, or double the assumed average value. Guagnano, Stern, and Deitz predicted the dominating influence of barriers to behavior as its value approached extreme levels (Guagnano, Stern, and Deitz, 1995, pg. 704.)

Figure 4-17 tests the sensitivity to the range of values for external laws.

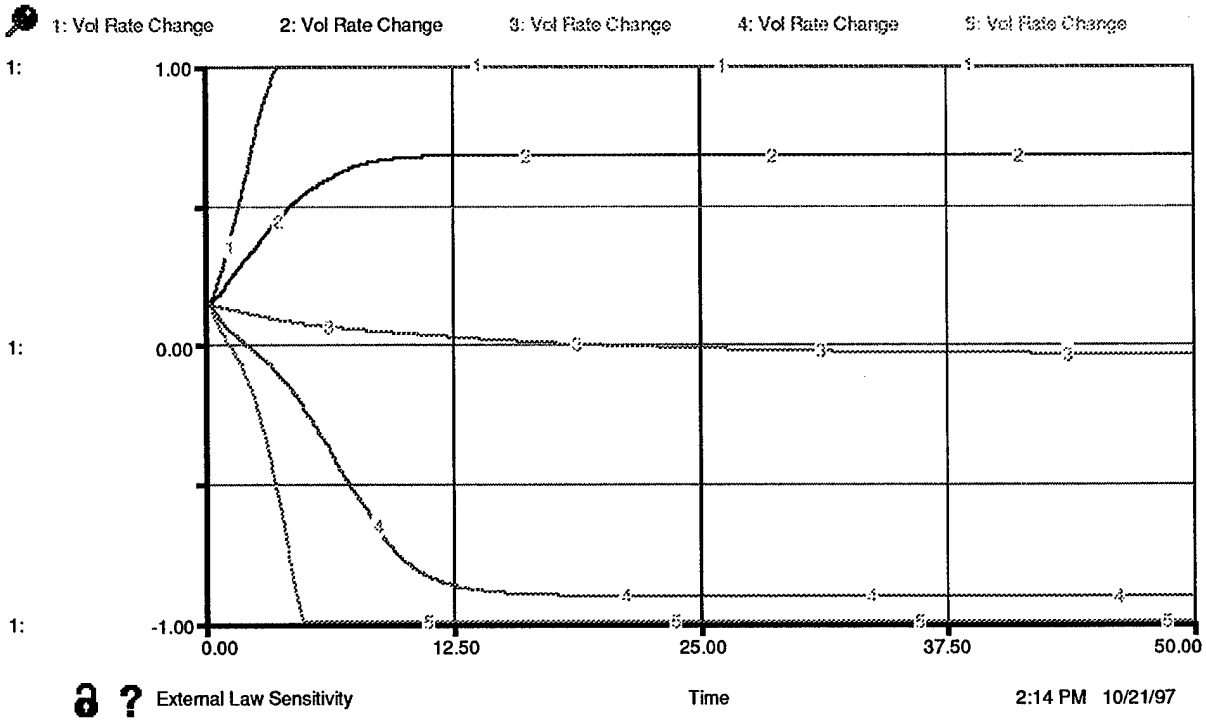


Figure 4-17 Sensitivity Test of External Laws

The lines on the graph correspond to values of external laws starting at negative point five (top) and increasing to point five (bottom.) Increasing or decreasing the range of values only takes the system to respective extreme levels faster, and the results are not shown. Here we see that extremely high values of external laws mandating waste reduction do cause all waste to be diverted from the waste stream, while extremely high values of external laws mandating waste generation cause the waste generation level to reach its maximum. The absence of laws results in

the slight reduction of waste generation, as seen in the initial output, which shared the same assumption. Guagnano, Stern, and Deitz predicted the dominating influence of external laws as its value approached extreme levels (Guagnano, Stern, and Deitz, 1995, pg. 704.)

Figure 4-18 tests the sensitivity to the range of values for incentives.

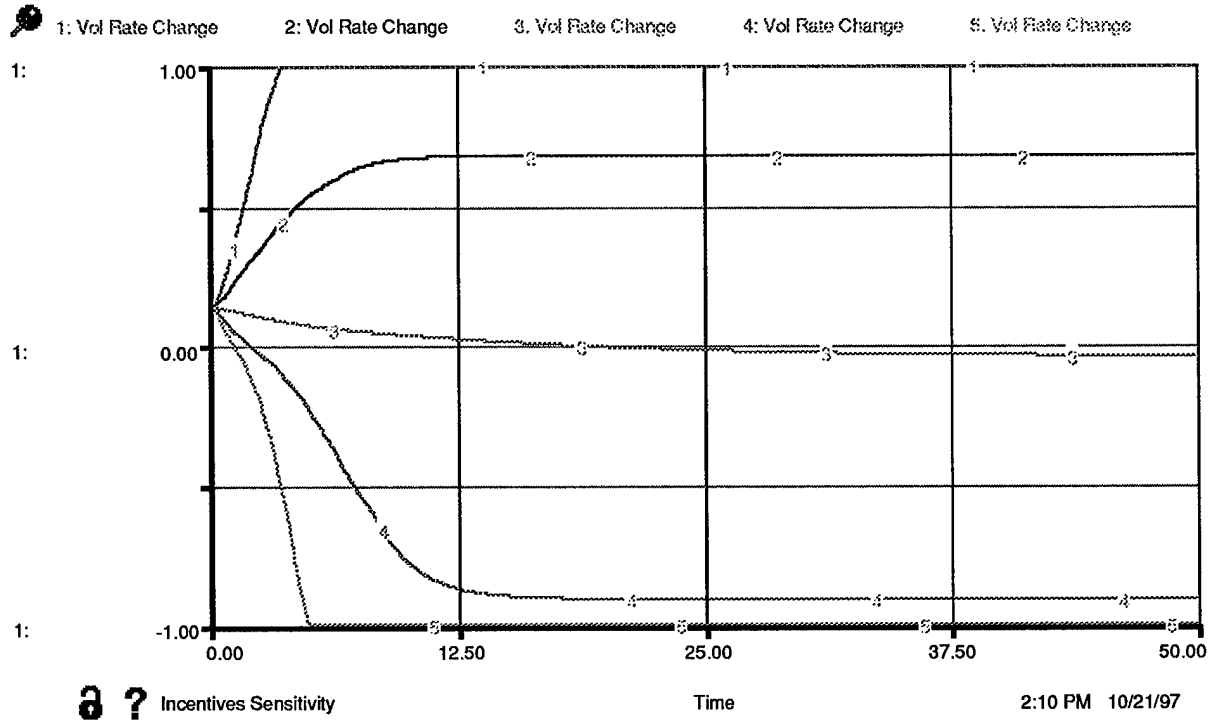


Figure 4-18 Sensitivity Test of Incentives

The lines on the graph correspond to values of incentives starting at negative point five (top) and increasing to point five (bottom.) Increasing or decreasing the range of values only takes the system to respective extreme levels faster, and the results are not shown. Here we see that extremely high values of incentives encouraging waste reduction do cause all waste to be diverted from the waste stream, while extremely high values of incentives encouraging waste generation cause the waste generation level to reach its maximum. The absence of incentives results in the slight reduction of waste generation, as seen in the initial output, which shared the same assumption. Since external laws and incentives are assumed to influence the change in

behavior in the same manner (independent and additive), Figures 4-14 and 4-15 are identical. Guagnano, Stern, and Deitz predicted the dominating influence of incentives as its value approached extreme levels (Guagnano, Stern, and Deitz, 1995, pg. 704.)

Figure 4-19 tests the sensitivity to the range of values for training.

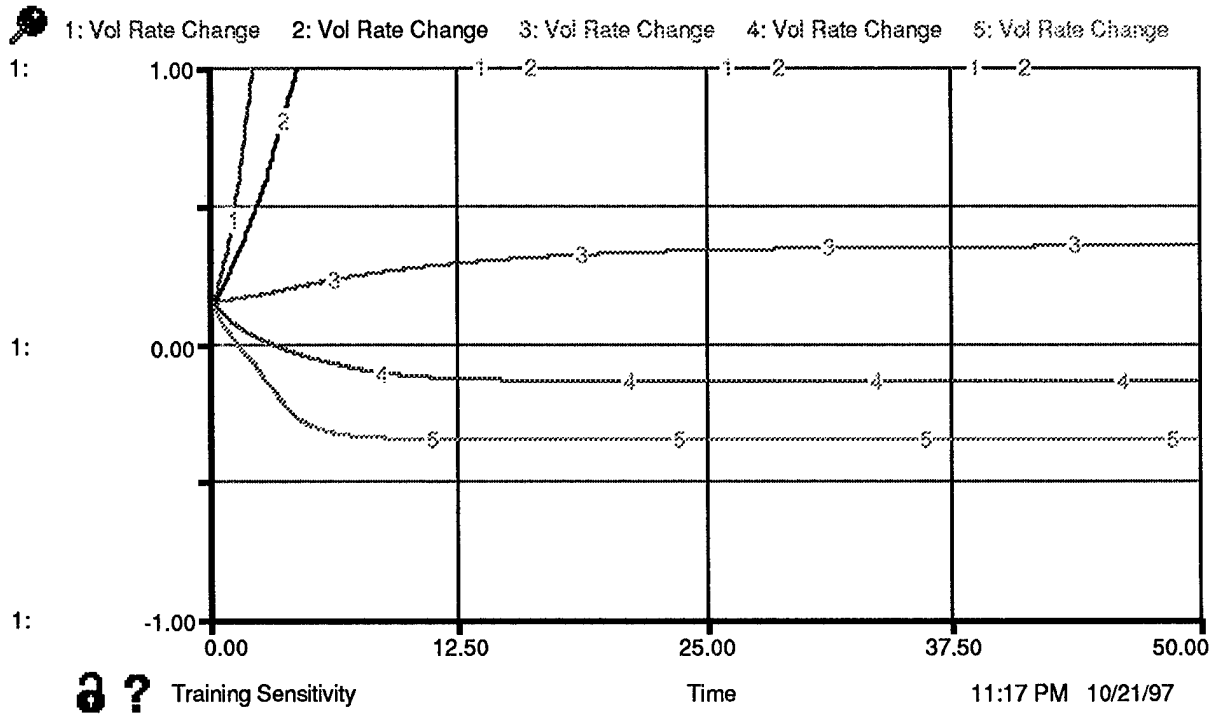


Figure 4-19 Sensitivity Test of Training

The lines on the graph correspond to values of training starting at negative one (top) and increasing to one (bottom.) Here we see that extremely high values of training in waste reduction do cause more waste to be diverted from the waste stream, but extremely high values of training in waste generation cause the waste generation level to reach its maximum. The absence of training results in the slight reduction of waste generation, as seen in the initial output, which shared the same assumption. Remember that training affects the beliefs rather than behavior directly, therefore the response is not the same as that of external laws or incentives. Training has a greater influence on keeping the community in line with expected behavior rather than

encouraging more stringent behavior. Guagnano, Stern, and Deitz predicted the dominating influence of training as its value approached extreme levels (Guagnano, Stern, and Deitz, 1995, pg. 704.)

As illustrated in the above four figures, the model is very sensitive to each of the four external variables. The extreme policy test included an example of how the variables may interact despite the cited independence of the variables. Further investigation of the interactions of the external variables, both with each other and with the behavior system, needs to be conducted. Since the response agrees with the reference mode, the structure is adequate for understanding of the system, despite its sensitivity to the external influences, as discussed earlier in the boundary adequacy (structure) test.

Tests of policy implication:

14. System-improvement test: It is beyond the scope of this thesis effort to actually implement strategy. The focus is on gaining confidence in the model. Forrester and Senge stated that this test would not be valuable until confidence in the model is gained (Forrester and Senge, 1980, pg. 224.) As a result, this test is not used. However, we can see possible results from this test in the implementation section to follow. That section demonstrates the results of altering the external influences. We already have an intuition from the literature that any non-sustained change to the external factors will allow the model response to return to its original steady state. The results of altering the external influences will be discussed further in the implementation section.

15. Changed-behavior prediction test: This test can also be seen in the implementation section. It is not the objective to actually implement policy, but some tests have been implemented in the real world, such as an increase in laws mandating waste reduction. There are

other confounding influences in the real world system that are not in the model, such as economics and politics. These influences do not help this model in achieving its purpose, however, which is to gain insight into the attitude-behavior system. They would help give a more precise response, but the current structure gives the response expected from the reference mode. As discussed below, however, the results from the model are expected when changes to the legislation are made.

16. Boundary-adequacy (policy) test: Although previous iterations of model development tested the adequacy of the boundary, there were no real policy changes that were tested. Different mechanisms for the feedback from behavior to beliefs were experimented with before the final mechanistic representation was used. Again, however, such alterations better fit the boundary adequacy (behavior) test as they were not true alterations of policy as much as alterations of structure.

17. Policy-sensitivity test: This test is best illustrated using the results of the parameter verification test on the sensitivity of the external influences. Referring to Figure 4-16, the sensitivity of the waste volume rate when training is altered suggests certain policy recommendations. Specifically, attempting to increase favorable incentives to reduce solid waste will become more difficult as the marginal rate of return is decreased. The difference between a value of zero and point five is much greater than volume rate change between point five and one, a comparable change, suggesting that more results for the same level of effort will be experienced in the lower values of training. This is especially true as the value of one is approached because the possibility of perfect training is improbable given the cost to actually achieve such a goal. This conclusion may lead us to believe that the structure of the model is inadequate in that it does not consider economic considerations, but the original scope of the model is achieved without

such structure. As mentioned earlier, when checking the model boundary, the purpose of the model must be considered. Reasonable, mechanistic structure may give better results, but if it does not better achieve the purpose of the model, then it is not necessary. Economic structure does not aid in understanding of how the attitude/behavior system works or how external influences affect the system. Further, policy recommendations do not change with such structure.

Implementation

Before implementing this model, it is important to identify the usefulness of the model. Again, one problem identified in Chapter One is the difficulty for a community to maintain optimum procedures when trying to reduce solid waste, especially in a dynamic behavioral system. This model, once considered valid through the previous tests, can be used to test various implementations and see if the response is the one desired. This model cannot be used to determine which is the best method to reduce generation by one pound per person per year or by half of the current waste generation rate. As discussed in Chapter Three, two tests will be conducted to demonstrate the utility of this model. The results of these tests now follow.

First, the training will be altered, both with a pulse increase in value at year twenty and a step increase at year forty. It was previously mentioned that any unsustained change to the training will allow the waste volume level to return to its original steady state. Therefore we would expect to see the pulse input create a momentary increase in recycling and the step input to permanently increase the waste reduction. Figure 4-20 illustrates the results.

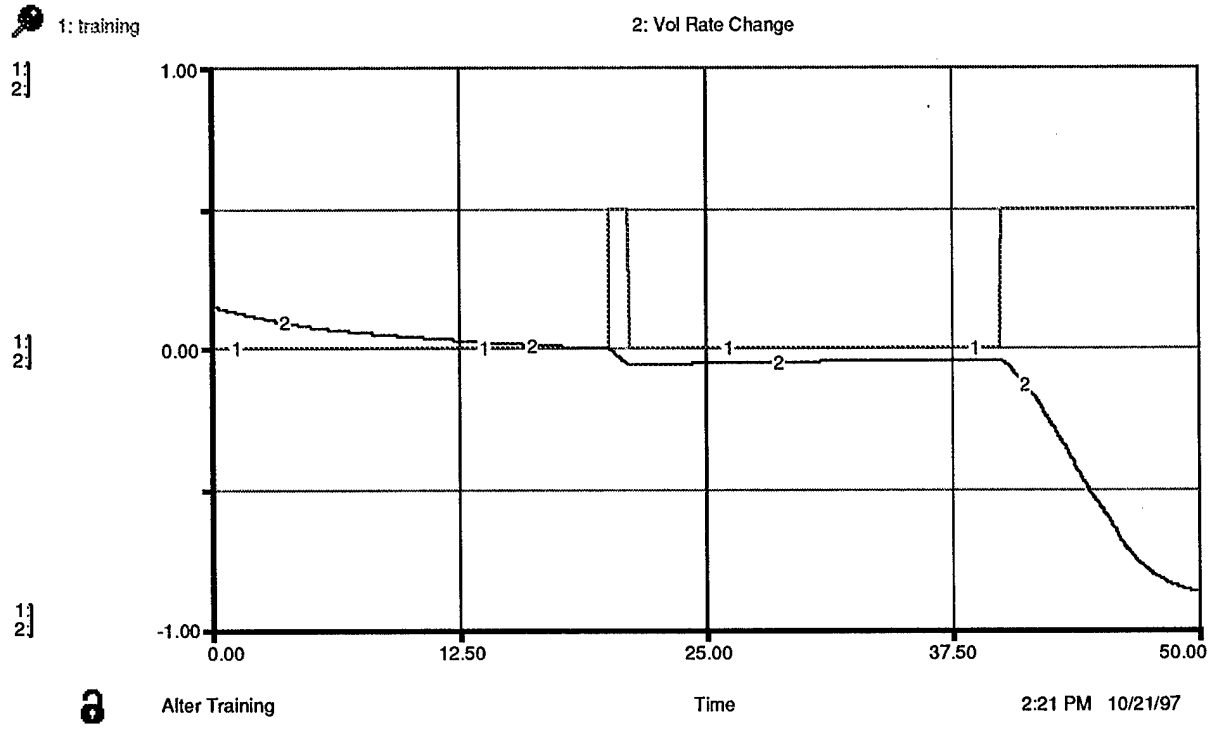


Figure 4-20 Alter Training Level

As seen above, the waste volume level does indeed decrease, both momentarily and permanently. This corresponds to responses visible in the real world system. As the training on how to decrease waste increased, the waste level decreased, as it should. When the training ended, the community behavior returned to its original state as did the waste volume rate. However, sustained training managed to keep the waste volume rate at its new steady state level.

Next, the external laws will be altered, both with a pulse increase in value at year twenty and with a step increase at year forty. Note that a pulse in laws is unrealistic but is used for demonstration purposes here. Any change in laws are usually permanent, or at least remain in effect until the laws can be removed, which may take several years. We would expect the waste volume level to decrease momentarily in response to the pulse increase and decrease permanently in response to the step increase. Figure 4-21 illustrates the results.

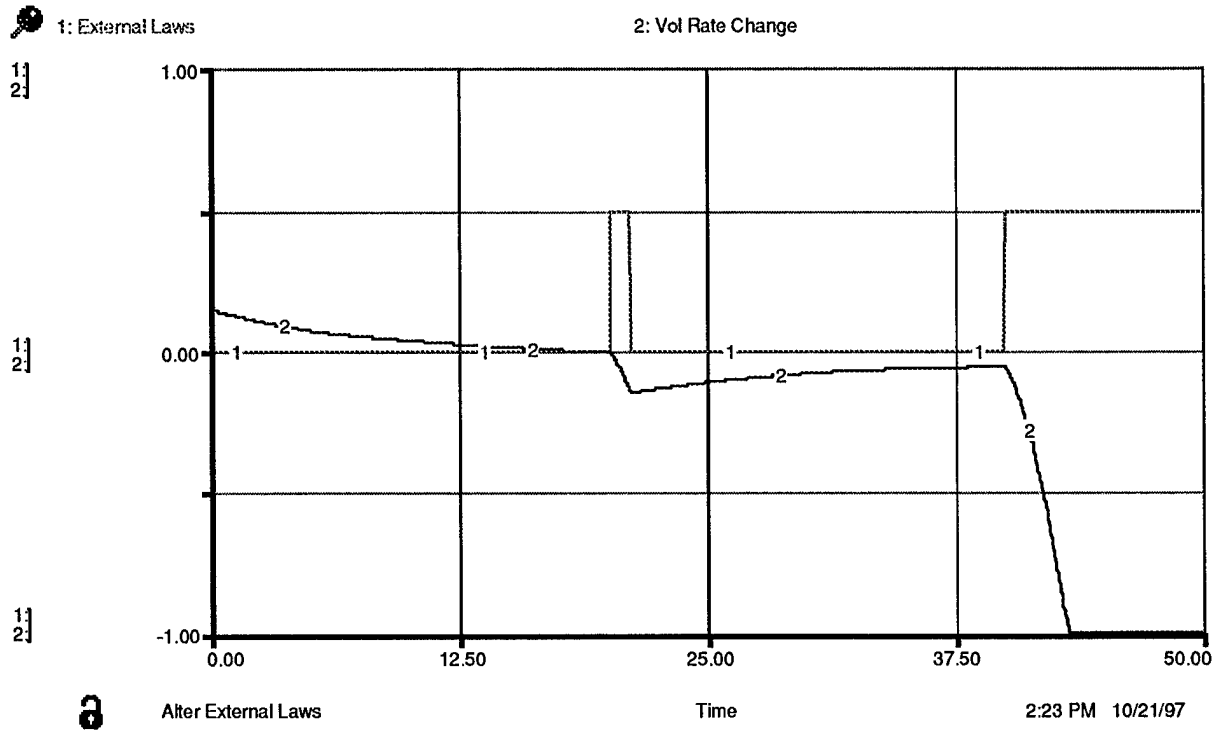


Figure 4-21 Alter External Law Level

As seen, the waste volume level again does indeed decrease, both momentarily and permanently. This corresponds to responses visible in the real world system. Although not as drastic, due to other factors as mentioned earlier, increases in external laws have resulted in a decrease in waste generation. Note however, that at a sustained external law value of .4, the waste volume rate decreases to zero which is unrealistic. This corresponds to the result found in the extreme conditions test noted earlier. However, if the value is altered to an implausible value momentarily, as in the one year pulse, the system does not have time to reach the unrealistic state, making the response seem plausible.

Chapter 5
Conclusions

Introduction

There has been much literature on attitude-behavior relationships that suggests research should include an investigation of the causality of the system. The dynamic structure should be investigated in an effort to understand how different components of the system interact over time. Also, the system should be investigated for feedback loop structures that might help predict system response over time. A system dynamics approach is representative of such a study, and will be useful in understanding attitude-behavior systems in an attempt to encourage the desired behavior of a community, such as efforts that are beneficial to a community or the environment like waste reduction.

This thesis has illustrated the usefulness in studying the theory of reasoned action in a system dynamics manner by constructing a model and testing it under varying circumstances. The model allows a visual representation of the system response over time. Validation testing of the model has increased confidence that the model does produce the expected response over time based on current understanding of the theory of reasoned action. Confidence in the model leads to confidence in the system dynamics approach to investigating attitude-behavior relationships as suggested by the literature. The testing also increases understanding of the dynamic interaction of the various model components. This understanding can be very beneficial to managers who are trying to encourage environmentally favorable behavior of the community, like the reduction of solid waste.

The contribution of this thesis is in the understanding of attitude-behavior relationships. If we are to manage systems that are a result of behavioral response, then understanding why the

behavoirs occur is very important. As many researchers have postulated, the attiitude-behavior relationship is a dynamic system of causal influences. This thesis allows investigation of these relationships. Such investigation will either help to credit current research or guide further research. However, in order to be able to further investigate attitude-behavior theory, further investigation of the model needs to be addressed, such as determining the relative weights of the external and demographic variables.

This chapter will discuss the answers to the specific questions addressed by this thesis, strengths and weaknesses of the thesis, recommendations, and finally area of further study.

Answers to Research Questions

The intent of the thesis effort was to gain an understanding of the dynamic influence structure of the attitude-behavior system in order to better control the outcomes of the system and achieve the modifications to behavior that are desired in terms of solid waste reduction. The attitude-behavior system utilized was the theory of reasoned action, with the main components being behavioral and social beliefs, attitudes, subjective norms, intentions, and behaviors. The external influences incorporated were barriers to behavior, external laws, incentives, training, and demographics. The demographic variables studied were age, political ideology, income, environmental knowledge, education, gender, and location. In order to change behaviors, beliefs must be changed. This can be done through training or by altering the demographics of the society. Another way to alter behaviors is to modify the intention after it has been established. To reduce the generation of waste, barriers to performing the behaviors must be removed, external laws favoring waste reduction must be increased, or incentives to reduce waste must be increased.

Although these insights are useful, they are rather basic. However, understanding of the model suggests other less obvious conclusions. For instance, Figure 4-13 illustrates a difference in response when the weightings of behavioral and normative beliefs are altered. The model shows that move favorable behaviors result when more weighting is placed on normative beliefs. If a community is very social and interactive, then resources may be better spent in the demographic areas than in the normative areas. Resources to increase the community's average income level may be more beneficial than using the resources to train the community at the individual level. Increasing the average income level may result in normative beliefs that are more favorable to reducing waste generation rates, which will indirectly influence behavioral beliefs through successive influences on other model components.

It is important to note that research question number three as identified in Chapter One is not fully answered. Although understanding of the system is gained, it is not possible to determine how to adjust the external influences to achieve desired waste generation reductions. The assumed values of the weights of the external and demographic variables may be valid, but they do not allow the investigation of magnitudes of changes to the level of waste generation rates. It is not possible to determine if resources are better spent training a community on how to reduce waste or incentivizing the waste generation reduction behaviors until the strength of influence of each component is determined. Further research needs to be placed in investigating the relative weighting of the variables

Strengths and Weaknesses

Strengths: A system dynamics approach allows us to better understand the relationships between components in an attitude-behavior system. We can visualize what influences the behaviors and what may be the best way to change those behaviors. If the objective is to reduce

waste being generated, then we can analyze the physical means of waste generation, such as too much packaging on retail products, and attempt to address these processes. However, waste is generated because people generate it, so it becomes important to ask why, rather than how, they generate waste. An attitude-behavior approach to understanding why waste is generated is a very important means of attempting to influence the generation of waste.

To find the optimal level of waste generation, the system must reach a steady state. This approach allows for the opportunity to visualize the process. For the system to reach steady state, the behavioral change must approach zero, creating a constant value in the behavior stock. That value should dictate the community's current effort level to reduce solid waste, based on the assumed external variable values.

Since the model values are subjective, any single run of the model will not give useful information. However, in comparing the steady state values when different variables are changed, we can gain insight into the usefulness of pursuing those changes. The model allows us to modify policy assumptions and quickly understand how the changes will affect the system response.

Quite possibly the most beneficial outcome of this approach is the questions that are raised by it. The theory of reasoned action is well documented and discussed, but it is not completely without question. This model will help highlight areas of study that need clarification, the accomplishment of which will result in a stronger theory. For instance, the outcome obtained suggests that the system is very sensitive to incentives, but not extremely sensitive to age. Further resources should be placed on understanding the relationship between incentives and behavior rather than age and behavior. Guiding further research is very important during this time of limited resources.

Weaknesses: The model is completely subjective. We cannot quantify the relationships, therefore we do not know what an increase in training in the model actually means in terms of money, resources, or labor hours spent. Also economic factors are not addressed specifically, but are assumed to be incorporated under the external factors. The comparison of perception of effort and perception of problem should be quantified, and would more than likely take on monetary values. Without these values, the actual translation of demographics to beliefs is uncertain. The general direction of the influence can be determined, but the magnitude of the response is unknown, resulting in a difficult translation to actual outcomes.

The relative weights of the external and demographic variables is not determined. Without actual knowledge of the strength of influence of each variable compared to the others, actual magnitudes of model response cannot be accurately determined. This prevents conclusions which suggest that one policy may be better than another. As stated earlier, the model response seen in Figure 4-13 suggests that when a community gives more weight to its normative beliefs than its behavioral beliefs, resources may be better spent in increasing average income levels that increasing training levels. However, if the actual weighting of these variables is unknown, then this conclusion may not be accurate. Further investigation into the weights of these variables needs to be made.

Incorrect assumptions may lead to the model incorrectly predicting actual behavior. Three such assumptions may be that underlying attitudes are not stable over time, verbal attitudes are not entirely adequate as measures of underlying attitudes, and attitudes are not powerful determinants of behaviors (Alwin, 1973, pg. 256.) This model assumes causality in some of the relationships, such as the demographic variables on beliefs, but the actual causal relationship is unknown. The model also assumes that components are modified only by the identified external

variables, when in fact, many other variable many interact at different times and with different magnitudes. The assumption that the values of the external and demographic variables are constant over time may not be correct due to changes in the community over time. However, it is doubtful that the community profile will change quickly enough to drastically alter the system response.

Recommendations

The model output suggests that in order to reduce waste, the beliefs that waste reduction is good must be increased through the use of training, or the intention to reduce waste must be supplemented by using incentives to encourage reducing waste, creating laws mandating waste reduction, and removing barriers to waste reduction. However, the magnitude of these factors greatly affects the response of the system, therefore their relationship to behavior needs to be further studied.

Suggestions for Further Study

With a basic model identifying the system established, it would not be hard to test other theories regarding attitudes and behavior, such as the theory of planned behavior. Also, approaches such as motivation, habit, and escalation of commitment can be investigated to aid in understanding of the mechanisms by which they influence the generation of solid waste. Influences as discussed by Downs, such as long term changes to perception due to media attention, could be included in the model in an attempt to understand long term cyclical changes to attitude-behavior theory.

Other areas for follow-on work include studying further the relationships among the demographic determinants. Some of these may influence others, which would eliminate the assumption of equal weighting. The actual causal relationships need further clarification also.

Other demographic determinants, although less documented, may show stronger relationships to actual waste reduction than the current list of determinants used in the model.

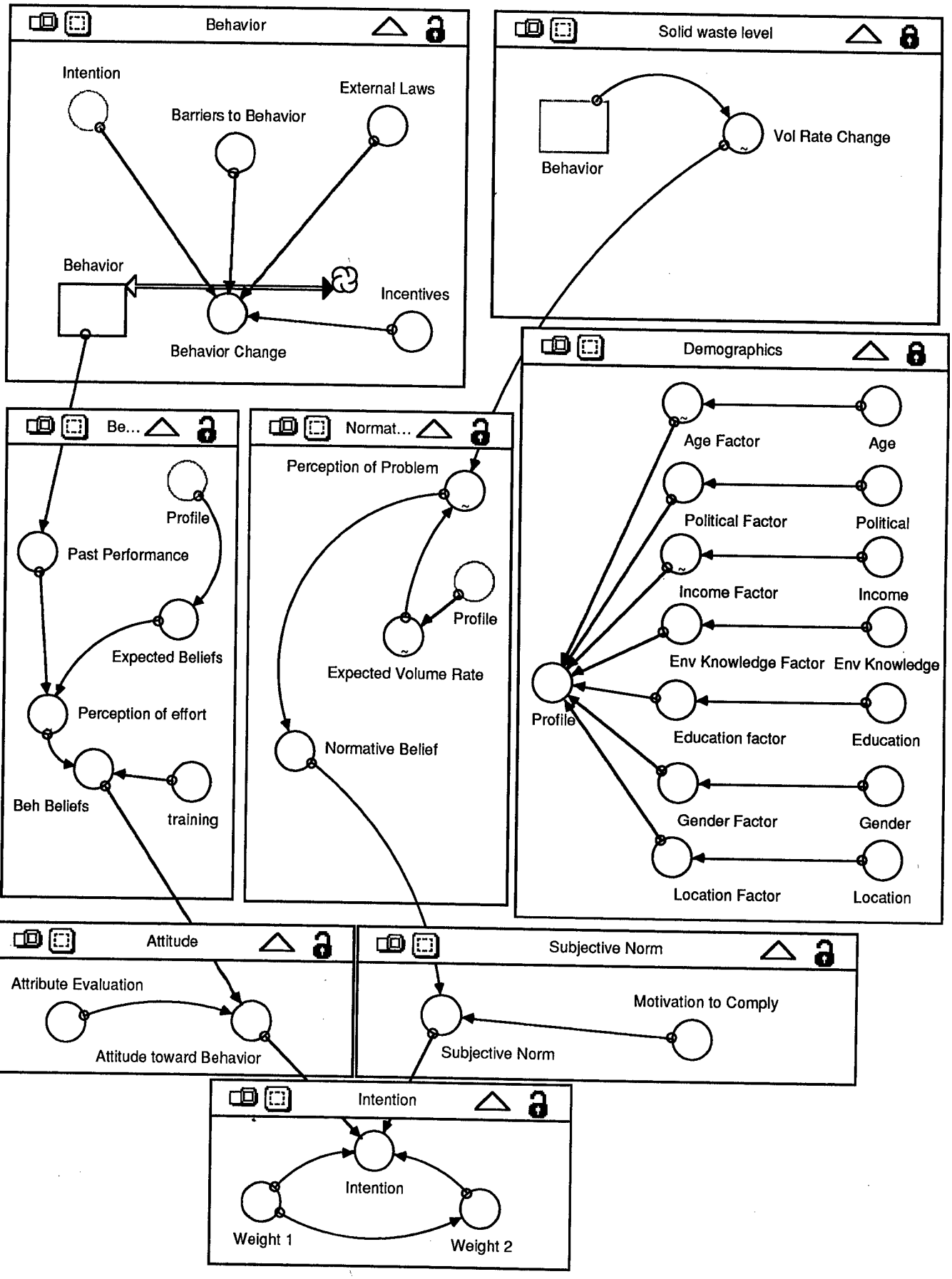
Effect of influences such as culture on immigrants adapting to their new environment and upon their children needs to be addressed (Noe and Snow, 1990, pg. 33.) The rate of change of beliefs may be different for the people moving into a community than for people who have been members of the community for a significant amount of time. This learning curve may be important if we are to understand why the general beliefs of a community change over time. It may be related to the dynamics of the community itself. For instance, as the heart of the town becomes the inner city due to affluent community leaders moving to the country, leaving behind poverty, the predictors now become dynamic. The model assumes that the predictor variables of a community are constant, signifying either a stagnant population, or an inflow of people with the exact ideals of the outflow of people.

One assumption that can be questioned is that all of the predictor variables are independent of each other, when in fact some may directly influence the others, such as level of income affecting the level of education of the next generation, which is included in the community population. The relationships of the external variables on each other need further investigation. The relationship between variables and perception can also be investigated to determine the proper representation of their relationships.

Finally, the subjective values of the model variables can be investigated. Means to determine values, such as surveys, can be investigated, while translating survey results into model values can also be addressed. Some type of meta-analysis can be conducted to determine which demographic variables are better predictors, with a path analysis conducted to determine causality among the variables. However, such results will not improve the model until the weights of each

variable can be determined. Therefore it is important to determine the relative strength of influence of the variables, possibly through surveys or statistical analysis. Once the weights have been determined, then refining the quantification of the model variables can be conducted, which should lead to a more accurate model response.

Appendix A
Flow Diagram


Behavior
Intention
External Laws
Barriers to Behavior
Behavior
Incentives
Behavior Change
Solid waste level
Behavior
Vol Rate Change
Demographics
Age Factor
Age
Political Factor
Political
Income Factor
Income
Env Knowledge Factor
Env Knowledge
Profile
Education factor
Education
Gender Factor
Gender
Location Factor
Location
Be...
Profile
Past Performance
Expected Beliefs
Perception of effort
Beh Beliefs
training
Normat...
Perception of Problem
Profile
Expected Volume Rate
Normative Belief
Attitude
Attribute Evaluation
Attitude toward Behavior
Subjective Norm
Motivation to Comply
Subjective Norm
Intention
Intention
Weight 1
Weight 2

Appendix B
Flow Diagram Equations

Behavioral Belief

○ Beh_Beliefs = Perception_of_effort+training
DOCUMENT: Beliefs are a result of the perception of level of effort being exerted to reduce waste. This perception is modified by the level of training received.
Belief (probability) that performing the behavior will lead to a given consequence (Lutz, 1977, pg. 197)

○ Expected_Beliefs = Profile
DOCUMENT: The community profile is translated into beliefs that an individual has about the "correct" level of behavior for reducing waste.

○ Past_Performance = Behavior
DOCUMENT: Past behavior is simply the previous level of behavior.

○ training = 0
DOCUMENT: This can be a value from -1 to 1, with one being all of the pro-recycling training required to fully complement one's beliefs and negative values representing training against recycling.

⊘ Perception_of_effort = GRAPH(Past_Performance-Expected_Beliefs)
(-1.00, 1.00), (-0.6, 0.51), (-0.2, 0.27), (0.2, 0.11), (0.6, 0.04), (1.00, 0.00), (1.40, -0.06), (1.80, -0.11), (2.20, -0.27), (2.60, -0.51), (3.00, -1.00)
DOCUMENT: Perception of effort compares past level of behavior with the expected behavior level. If past behavior is higher (positive values) then perception will be negative, implying that more effort is currently being done than is needed. If past behavior is lower (negative values) then perception will be positive, implying less effort is currently being performed than is expected by the community.

Attitude

○ Attitude_toward_Behavior = Beh_Beliefs*Attribute_Evaluation
DOCUMENT: A= Sum(behavioral beliefs * attribute evaluation)
Attitude towards the act is the individual's attitude toward (affect for or against) performing the behavior (Lutz, 1977, pg. 197)

○ Attribute_Evaluation = 1
DOCUMENT: individual's evaluation of the consequences (Lutz, 1977, pg. 197)

Behavior

□ Behavior(t) = Behavior(t - dt) + (Behavior_Change) * dt
INIT Behavior = 1

DOCUMENT: Specific action or Behavior (Lutz, 1977, pg. 197)

INFLOWS:
⇔ Behavior_Change = (Intention+Incentives+External_Laws)-Barriers_to_Behavior

○ Barriers_to_Behavior = 0
DOCUMENT: Physical Barriers will impede behaviors derived from intentions. (Fishbein and Ajzen, 1975, pg. 298)
This can be set from zero to one, with one being all possible barriers in place. This does not correspond to all recycling being stopped by barriers.

○ External_Laws = 0
DOCUMENT: This can be set from negative one to one, with one being 100% laws in place to reduce waste, and negative values actually indicating regulations in place to generate more waste.
Legislation is another way to produce effective behavior change - 100% in some cases (Gray, 1985, pg. 178.)

○ Incentives = 0
DOCUMENT: This can be set from -1 to 1, with one being incentives to reduce solid waste as much as possible and negative values corresponding to incentives not to reduce solid waste.
Incentives for newspaper recycling were found to produce the largest effects, compared to the other types of manipulations. (Gray, 1985, pg. 177.)

Demographics

○ Age = 30
DOCUMENT: Age can vary between 20 and 60, with 20 being highly in favor of reducing solid waste and 60 being highly against reducing solid waste.

○ Education = .7
DOCUMENT: Education can vary from -1 to 1. A high school education is represented by a -1, an undergraduate degree is represented by a 0, and a post graduate degree is represented by a 1.

○ Education_factor = Education
DOCUMENT: The education factoris equal to the education value.

○ Env_Knowledge = .5
DOCUMENT: Environmental knowledge can vary from -1 to 1. Low environmental knowledge is represented as a -1 and high environmental knowledge is represented by a 1.

○ Env_Knowledge_Factor = Env_Knowledge
DOCUMENT: The environmental knowledge factor is equal to the environmental knowledge value.

○ Gender = 0
DOCUMENT: Gender can vary from -1 (all masculine) to 1 (all feminine). Note this is a reflection of their beliefs, therefore men can have feministic beliefs and women can have masculinistic beliefs.

○ Gender_Factor = Gender
DOCUMENT: The gender factor is equal to the gender value.

○ Income = 30000
DOCUMENT: Annual income can vary from $12,000 to $36,000 (chosen arbitrarily) with $12,000 being against reducing solid waste and $36,000 being for reducing solid waste. The value ranges were approximated to be at the low and high ends of the national average income levels. The 95th percentile values would be best used here.

○ Location = .85
DOCUMENT: Location can vary from -1 (rural) to 1 (urban).

○ Location_Factor = Location
DOCUMENT: The location factor is equal to the location value.

○ Political = .7
DOCUMENT: Liberal is represented by a 1 while Conservative is represented by a -1. Liberal is in favor of reducing solid waste while conservative is against.

○ Political_Factor = Political
DOCUMENT: The political factor is equal to the political value.

○ Profile =
(Age_Factor*4/28+Env_Knowledge_Factor*4/28+Education_factor*4/28+Income_Factor*4/28+Location_Factor*4/28+Political_Factor*4/28+Gender_Factor*4/28)*-1
DOCUMENT: All are weighted equally. No evidence to support an unequal averaging technique.

⊘ Age_Factor = GRAPH(Age)
(20.0, 1.00), (24.0, 0.8), (28.0, 0.6), (32.0, 0.4), (36.0, 0.2), (40.0, 0.00), (44.0, -0.2), (48.0, -0.4), (52.0, -0.6), (56.0, -0.8), (60.0, -1.00)
DOCUMENT: Age is normalized by assuming it is inversely linearly proportional to the age value, with 20 corresponding to 1 and 60 corresponding to -1. The age values represent the average age extremes for a given community. In the event that the mean community age is lower or higher than the extremes, the age factor will default back to the 1 or -1 values. I assume that a community with a mean age higher than 60 will have different views about waste different from a community with a mean age of fifty. A similar assumption is made for mean ages lower than 20.

⊘ Income_Factor = GRAPH(Income)
(12000, -1.00), (14400, -0.8), (16800, -0.6), (19200, -0.4), (21600, -0.2), (24000, 0.00), (26400, 0.2), (28800, 0.4), (31200, 0.6), (33600, 0.8), (36000, 1.00)
DOCUMENT: The income factor is normalized by assuming it is linearly proportional to the income level. The income factor corresponds to -1 at very low levels of income, increasing linearly to 1 at high levels of income.

Intention

○ Intention = Attitude_toward_Behavior*Weight_1+Subjective_Norm*Weight_2
DOCUMENT: Behavioral intention is the individual's intetnion to perform that action (Lutz, 1977, pg. 197)

○ Weight_1 = .5
DOCUMENT: This, along with weight 2, would be empirically derived. Both weights must sum to 1. (Lutz, 1977, pg. 197.)

○ Weight_2 = 1-Weight_1
DOCUMENT: This, along with weight 1, would be empirically derived. Both weights must sum to 1. (Lutz, 1977, pg. 197.)

Normative Belief

○ Normative_Belief = Perception_of_Problem
DOCUMENT: Normative Beliefs are the individual's perception of the expectations of the referents with respect to the behavior. (Lutz, 1977, pg. 197)

⊘ Expected_Volume_Rate = GRAPH(Profile)
(-1.00, 1.00), (-0.8, 0.43), (-0.6, 0.2), (-0.4, 0.07), (-0.2, 0.02), (-6.66e-017, 0.00), (0.2, -0.06), (0.4, -0.16), (0.6, -0.28), (0.8, -0.54), (1, -1.00)
DOCUMENT: The community profile is translated into a volume rate that an individual would assume is the "correct" waste level.

⊘ Perception_of_Problem = GRAPH(Vol_Rate_Change-Expected_Volume_Rate)
(-2.00, -1.00), (-1.60, -0.6), (-1.20, -0.32), (-0.8, -0.15), (-0.4, -0.04), (-1.33e-016, 0.00), (0.4, 0.04), (0.8, 0.12), (1.20, 0.29), (1.60, 0.6), (2.00, 1.00)
DOCUMENT: Compare's society's expectations with actual flow. If expectations are lower than the volume rate (positive values) then a positive perception of a problem will exist, implying that there is more waste being generated than society finds acceptable . If expectations are higher (negative values) then there will be negative perception of a problem, implying that there is less waste being generated than society finds acceptable.

Solid waste level

⊘ Vol_Rate_Change = GRAPH(Behavior)
(0.00, 1.00), (0.3, 0.6), (0.6, 0.35), (0.9, 0.18), (1.20, 0.07), (1.50, 0.00), (1.80, -0.07), (2.10, -0.18), (2.40, -0.35), (2.70, -0.6), (3.00, -1.00)
DOCUMENT: Assuming a behavior of 1.5 gives a typical per capita disposal rate, a behavior of 0 will give a disposal rate of one, which is 100% higher than the average, or double the average. A behavior of +3 will give a disposal rate of negative one, or one hundred percent lower than average. Note the extreme of negative one implies no waste is being generated.

Subjective Norm

○ Motivation_to_Comply = 1
DOCUMENT: This is poorly understood, but results obtained without it are as good or better than those obtained with it. Therefore I will set it to one, so it will not modify the SN.
The individual's motivation to comply with the referents expectations. (Lutz, 1977, pg. 197)

○ Subjective_Norm = Normative_Belief*Motivation_to_Comply
DOCUMENT: SN=Sum(normative beliefs*motivation to comply)

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Vita

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He was first assigned to the 14th Civil Engineer Squadron, Engineering Flight, at Columbus Air Force Base, Mississippi, as the Chief of SABER. Within one year, he become the Deputy Maintenance Engineer in the Maintenance Element of the Operations Flight. After a 91 day TDY duty as the Mechanical Engineer in Dhahran, Kingdom of Saudi Arabia, he returned to his position as Deputy Maintenance Engineer at Columbus Air Force Base. In May of 1996, he entered the School of Engineering at the Air Force Institute of Technology. Upon graduation, he will be assigned to the 305th Civil Engineer Squadron, McGuire AFB, NJ, as the Chief of Maintenance Engineering.

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13. ABSTRACT *(Maximum 200 words)*

The relationship between attitudes and behavior is investigated in regard to the reduction of solid waste in a community. The theory of reasoned action, as identified by Ajzen and Fishbein in 1975, is investigated using as system dynamics approach. The closed loop system structure that would produce the expected real-world response is established. The structure is then translated into a flow diagram and coded into a mathematical model. The model quantifies the values of beliefs, attitudes, intentions, behaviors, external and demographic variables, perceptions, and waste generation levels in order to illustrate how each changes over time when influenced by other variables. The model is tested to verify a model response in agreement with the expected outcome. Finally, suggestions of possible uses of the model are illustrated and discussed. Possible uses include investigating the relative weights of the demographic and external variables, investigating responses to different policies, testing other attitude-behavior theories, and guiding future research in attitude-behavior theory.

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